Government of Western Australia
School Curriculum and Standards Authority

STEM Education in Western Australian Schools

2016 Update

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Glossary

Before you read further, you may find this glossary helpful.

ATAR	Australian Tertiary Admission Rank
ICSEA	Index of Community Socio-Educational Advantage
ICT	Information and Communication Technologies
General courses	Courses which are not examined by the Authority and are aimed at students who will enter further training or the workforce from school
NAP – ICT Literacy	National Assessment Program
NAP – Science Literacy	National Assessment Program
NAPLAN	National Assessment Program – Literacy and Numeracy
OECD	Organisation for Economic Cooperation and Development
OLNA	Online Literacy and Numeracy Assessment
PISA	Programme for International Student Assessment
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
TISC	Tertiary Institutions Service Centre
VET	Vocational Education and Training
WACE	Western Australian Certificate of Education

Executive Summary

This paper provides an update on participation rates and achievement (particularly in relation to national and international assessments) in STEM subjects in Western Australian primary and secondary schools. Within the context of this paper, STEM education refers to education in science, technology, engineering and mathematics.

Participation rates

In Years P–10, all Western Australian schools are required to teach mathematics and science (incorporating biology, chemistry, earth and environmental science and physics) as part of the mandated curriculum.

In Years 11 and 12, students choose to enrol in specific mathematics and science courses which meet their needs and interests. A comparison of Year 12 examination enrolments in STEM subjects in 2005 and 2016 (as a percentage of the weighted ABS population for the total age cohort) indicates the following:

Mathematics

In Western Australia (WA), enrolments in ATAR Mathematics courses over the last decade are difficult to compare due to the complex nature of mathematics course offerings during the period 2010 to 2015.

- Calculus (2005)/Mathematics Specialist (2016) – has declined from 5.6% to 4.3%.
- Applicable Mathematics (2005)/Mathematics Methods (2016) – has declined slightly from 14.4% to 13.5%, but precise comparisons are not possible.
- Discrete Mathematics (2009)/Mathematics Applications (2016) – has increased from 22.6% to 26.4%, but precise comparisons are not possible.

Science

In WA, enrolments in ATAR Science courses have increased over the last decade, although the percentage enrolments have remained at fairly consistent levels. The percentage of students enrolled in Year 12 Chemistry has increased during this period.

- Biology – has declined slightly from 5.7% to 5.4%.
- Chemistry – has increased from 12.0% to 14.9%.
- Earth and Environmental Science/Geology – has increased from 0.2% to 0.8%.
- Human Biology – has declined very slightly from 14.8% to 14.1%.
- Physics – has remained relatively static - 10.5% to 10.4%.

Information and Communication Technologies

ICT enrolments fell sharply in 2009 and have remained relatively low since then.

- ICT (Applied Information Technology plus Computer Science) – has declined significantly from 5.0% to 3.3% over the period 2008 to 2016.

In 2016, for students on an ATAR pathway:

- 93.4% of students were enrolled in one or more mathematics courses (89.6% in an ATAR mathematics course and 3.8% in a General mathematics course)
- 72.1% of students were enrolled in one or more science courses (71.1% in an ATAR science course and 1.0% in a General science course).

In 2016, for students not on an ATAR pathway:

- 96.4% of students were enrolled in one or more mathematics courses
- 29.4% of students were enrolled in one or more science courses; additionally 30.9% of this cohort achieved a VET Certificate II or a higher qualification classified as science-based (science, engineering, health or ICT).

Access and aspiration in low ICSEA school environments

An analysis of enrolments by socioeconomic background indicates significantly lower levels of enrolment in ATAR STEM subjects in socioeconomically disadvantaged schools. Data from 2016 enrolments indicate that students in schools in the lower ICSEA categories, compared with those in the higher ICSEA categories, are much less likely to take four ATAR courses (and thereby qualify for an ATAR for university entrance), and much less likely to study the two most challenging mathematics courses, physics or chemistry.

STEM achievement

This paper investigates the performance of Western Australian students in national and international assessments of STEM achievement, including TIMSS, PISA, NAP Science Literacy, NAP ICT Literacy, and NAPLAN.

It is difficult to make generalised conclusions on Australian students' achievement in STEM from the results of internationalised assessments such as TIMSS and PISA. The results are somewhat inconsistent in terms of country rankings. There are significant cultural differences between the countries and regions that participate in these assessments, and there are possible issues regarding the methodology and administration of these assessments in different settings.

The results of the international tests generally place Australia around the middle (TIMSS) or higher (PISA) on the list of participating countries. However, the results suggest that Australia's performance in absolute terms is stagnating, and that Australia is slipping in terms of international rankings. While media commentary often overstates the current situation as a crisis in STEM education in this country, there is little doubt that there is room for considerable improvement in our performance.

Two aspects of the international test results that have attracted the attention of several commentators are:

1. Australia has a long tail of student under-achievement, and socioeconomic background is an important determinant of achievement;
2. The need to attract high quality teachers, addressing the issue of non-specialist teachers teaching out-of-field (especially in Years 7-10), and enhancing the effectiveness of classroom teaching.

What do we want to achieve?

It is widely recognised that society is being transformed by innovations in science and technology and it seems certain that this trend will continue for the foreseeable future. Globalisation brought about through the ongoing revolution in digital technology is having a major impact on all aspects of modern life, including the way we live, work and play.

In WA, some recent initiatives to improve STEM outcomes are in place. However, if we are to improve students' achievement in STEM, it is clear that more needs to be done.

To further progress achievement of a STEM agenda in schools the following objectives summarise a possible way forward.

- Create a strong profile for STEM and establish a school culture where the importance of STEM is recognised and valued – including a whole-of-school collaborative effort. (Note: STEM is NOT a new or separate subject – the mandated curriculum in STEM subjects is already articulated in the Western Australian Curriculum).
- Increase student participation in STEM subjects, both in overall terms and in the selection of 'difficult' options.
- Provide opportunities and support for students in low socioeconomic situations, and increase student aspirations.
- Provide learning opportunities that support both the development of knowledge and the acquisition of higher order skills such as problem solving, quantitative skills, critical thinking and communication skills.
- Attract and retain high calibre STEM teachers.
- Provide professional development opportunities for teachers in STEM content knowledge, and pedagogical content knowledge.
- Encourage partnership and outreach programs between schools and educational/professional/ community organisations.

Introduction

This paper provides an update on participation rates and achievement (particularly in relation to national and international assessments) in STEM subjects in Western Australian primary and secondary schools. Within the context of this paper, STEM education refers to education in science, technology, engineering and mathematics.

It is widely recognised that society is being transformed by innovations in science and technology, and it seems certain that this trend will continue for the foreseeable future. Globalisation brought about through the ongoing revolution in digital technology is having a major impact on all aspects of modern life, including the way we live, work and play.

There has been a plethora of Australian reports on STEM education in recent years[1–6], all of which emphasise its importance. These reports put particular emphasis on the importance of STEM education with regard to:

- improving economic prosperity (STEM has a critical role in productivity and economic success);
- future job prospects (it has been estimated that 75% of the fastest growth occupations require STEM skills)
- improving the quality of life (society is increasingly dependent on science and technology).

Importantly, we should add that STEM education also provides students with the knowledge and skills regarded as essential for individuals to:

- meet the demands of everyday life and work in a knowledge-based economy
- participate effectively in a multicultural democratic society – of increasing importance as we seem to be moving into what Australia's Chief Scientist has described as a 'post-truth' world.[7]

Most of the reports identified above express serious concerns regarding the state of STEM education in Australia. These concerns tend to focus on: declining enrolments in senior secondary STEM subjects; declining enrolments in university STEM degrees; and declining performance (in absolute and/or relative terms) on national (e.g. NAPLAN and NAP sample) and international measures (e.g. TIMSS and PISA) of STEM achievement across primary and secondary schooling.

The focus of this paper is on participation rates and achievement in STEM subjects in Western Australian primary and secondary schools.

Participation rates in STEM education in primary and secondary schools in Western Australia (WA)

Requirements of the Western Australian Curriculum

The Western Australian Curriculum[8], adopted and adapted from the Australian Curriculum, sets out the knowledge, understandings, skills, values and attitudes that students are expected to acquire in Years P–10 in WA and guidelines for the assessment of student achievement. The Curriculum addresses eight learning areas: English; Mathematics; Science; Humanities and Social Sciences;

Physical and Health Education; Technologies; the Arts; and Languages. Content is specified in year syllabuses (as core and optional/additional) and these syllabuses form the framework against which a student's achievement can be described.

In Years P–10, all schools in WA are required to teach Mathematics and Science (incorporating Biology, Chemistry, Earth and Environmental Science and Physics) as part of the mandated curriculum. Schools are required to report to parents on student achievement in mathematics and science twice a year.

In Years 11–12, to achieve a Western Australian Certificate of Education (WACE), students must complete a minimum of 20 course units or the equivalent. These units are usually chosen from ATAR subjects (which have a Year 12 external examination), General subjects (which are school assessed, but with an externally generated assessment in Year 12) and VET programs. Students must complete four or more Year 12 ATAR courses (potentially leading to university study) or a Certificate II or higher (potentially leading to further vocational education and training or work). In addition, students must demonstrate a minimum standard of literacy and numeracy, either through achievement of Band 8 or higher in their Year 9 NAPLAN assessment or through the Online Literacy and Numeracy Assessment (OLNA). Students can exercise a wide degree of choice in the subjects that they select, but to achieve a WACE they must choose at least one list B subject (which incorporates mathematics, science and technology subjects).

Year 11 and 12 Participation in STEM Subjects in WA

In the report, *Optimising STEM Education in WA Schools*[6], (Hackling, Murcia, West and Anderson 2014) presented nationwide data comparing Year 12 examination enrolments in 1992 and 2012 which showed declining enrolments in most STEM courses, despite overall increases in school enrolments.

While these statistics are a cause for concern, the situation in WA is more positive.

A comparison of **Year 12 examination enrolments in STEM subjects** in 2005 and 2016 is set out below (and presented graphically in Appendix 1). It is important to note that the percentages provided are calculated relative to the **weighted ABS population for the total age cohort** (using the same methodology as that used by the Western Australian Tertiary Institutions Service Centre (TISC) to calculate the percentages of students who qualify for an ATAR).

Mathematics (2005/2016 comparisons)

- Calculus (2005)/Mathematics Specialist (2016) – 1601 to 1429 (5.6% to 4.3%)
- Applicable Mathematics (2005)/Mathematical Methods (2016) – 4154 to 4548 (14.4% to 13.5%) – difficult to compare with 2010–2015 Mathematics courses as subjects/stages are not directly comparable
- Discrete Mathematics (2009)/Mathematics Applications (2016) – 6519 to 8896 (22.6% to 26.4%) – difficult to compare with 2010–2015 Mathematics courses as subjects/stages are not directly comparable

Mathematics course enrolment comparisons over the last decade are difficult due to the complex nature of the mathematics course offerings during the period 2010 to 2015. It is clear that enrolments in the most challenging mathematics subject (Mathematics Specialist) have declined in both absolute and relative terms. This is consistent with trends nationally and across much of the western world. However, enrolments in Mathematics Methods and Mathematics Applications (both ATAR subjects) have remained strong. It is worth pointing out that in 2016, for **students on an ATAR pathway**, i.e. enrolled in four or more WACE examination courses (13,605 students or 58% of the cohort completing Year 12), 93.4% of students were enrolled in one or more mathematics courses (89.6% in an ATAR mathematics course and 3.8% in a General mathematics course).

Science* (2005/2016 comparisons)

- Biology 1653 to 1826 (5.7% to 5.4%)
- Chemistry 3683 to 5007 (12.0% to 14.9%)
- Earth and Environmental Science 47 (Geology) to 274 (EES) (0.2% to 0.8%)
- Human Biology 4258 to 4734 (14.8% to 14.1%)
- Physics 3021 to 3498 (10.5% to 10.4%)

In WA, enrolments in ATAR Science courses have increased over the last decade, although the percentage enrolments have remained at fairly consistent levels. The percentage of students enrolled in Year 12 chemistry has actually increased during this period.

In 2016, for **students on an ATAR pathway,** i.e. enrolled in four or more WACE examination courses (13 605 students or 58% of the cohort completing Year 12), 72.1% of students were enrolled in one or more science* courses (71.1% in an ATAR science course and 1.0% in a General science course).

For **students not on an ATAR pathway,** i.e. enrolled in three or less WACE examination courses (10 047 students or 42% of the cohort completing Year 12):

- 96.4% of students were enrolled in one or more mathematics courses (10.7% in an ATAR mathematics course and 85.6% in a General mathematics course)
- 29.4% of students were enrolled in one or more science* courses (3.8% in an ATAR science course and 25.6% in a General science course); additionally, 3108 students (30.9% of this cohort) achieved a VET Certificate II or a higher qualification classified as science-based (science, engineering, health or ICT).

Information and Communication Technologies (2008/2016 comparisons)

- ICT enrolments (Applied Information Technology plus Computer Science) 1502 to 1098 (5.0% to 3.3%) over the period 2008 to 2016.

ICT enrolments fell sharply in 2009 (1502 to 1014) and have remained relatively low since 2009.

* Footnote here

Role of universities in promoting participation in Year 11 and 12 ATAR STEM subjects

The external examination system used in assessing the Year 12 ATAR courses is an extremely important mechanism for maintaining high standards of student achievement in all subjects. Universities use the actual results students achieve as part of their admissions processes.

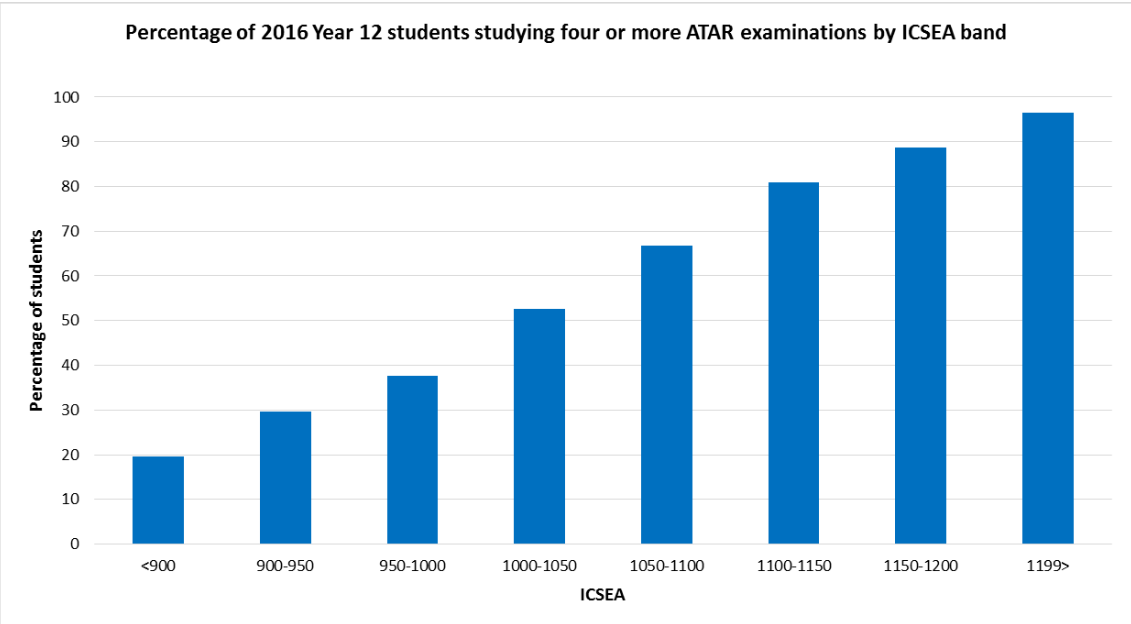
Universities can also play an important role in promoting STEM enrolments by establishing Year 12 ATAR course prerequisites for entry into specific degree programs, e.g. Engineering. However, there appears to be some reluctance on the part of universities to insist on course prerequisites.

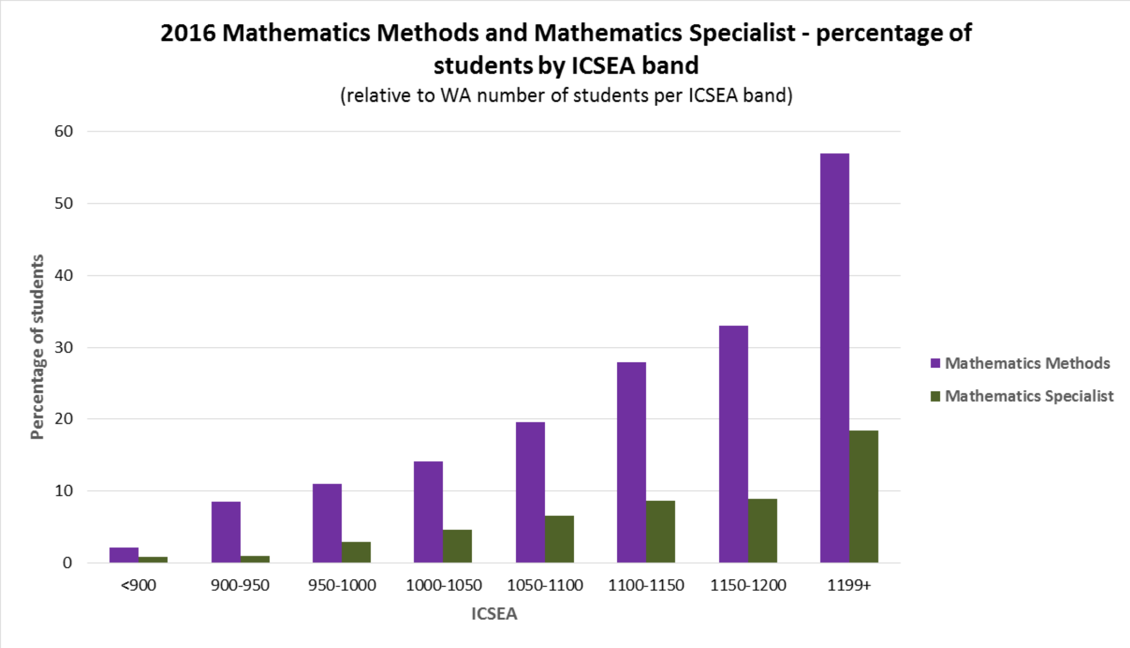
Access and aspiration in low ICSEA school environments

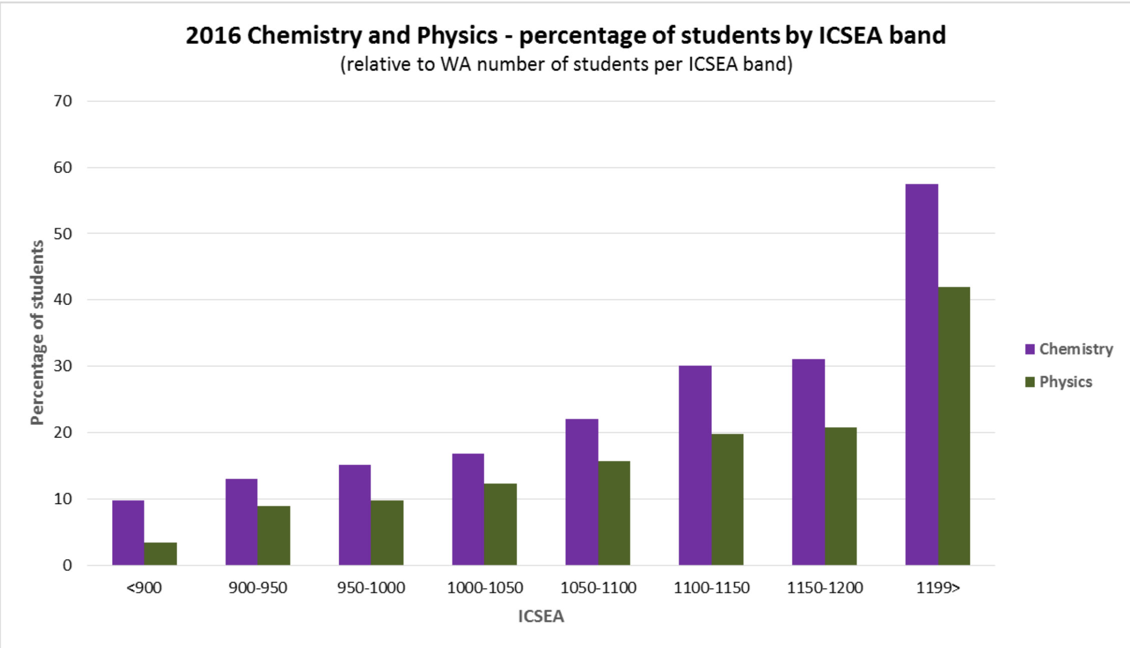
An analysis of enrolments by socioeconomic background indicates significantly lower levels of enrolment in ATAR STEM subjects in socioeconomically disadvantaged schools. The Index of Community Socio-Educational Advantage[9] (ICSEA) is a scale that represents levels of educational advantage. (Variables used in calculating the ICSEA include student-level data on the occupation and education level of parents/carers, and/or socioeconomic characteristics of the areas where students live, whether a school is in a metropolitan, regional or remote area, proportion of students from a language background other than English, as well as the proportion of Indigenous students enrolled at the school. A value on the scale assigned to a school is the averaged level for all students in the particular school.)

Data from 2016 enrolments indicate that students in schools in the lower ICSEA categories, compared with those in the higher ICSEA categories, are much less likely to take four ATAR courses (and thereby qualify for an ATAR for university entrance), and much less likely to study the two most challenging mathematics courses, physics and chemistry.

Figure 1: Percentages of 2016 Year 12 students enrolled in four or more ATAR courses, Mathematics Specialist and Mathematics Methods, and Physics and Chemistry as a function of ICSEA band







This data is extremely concerning and is indicative of a lack of opportunity and/or aspiration amongst students in low ICSEA schools. There is a significant need to address both the access of students to the more challenging mathematics and science courses, and the aspirations of students in low ICSEA schools.

Achievement (particularly in relation to national and international assessments) in STEM subjects in Western Australian primary and secondary schools

This section of the paper investigates the performance of Western Australian students in national and international assessments of STEM achievement. The assessments include TIMSS (Trends in International Mathematics and Science Study); PISA (Programme for International Student

Assessment); NAP Science Literacy (National Assessment Program); NAP ICT Literacy (National Assessment Program); and NAPLAN (National Assessment Program – Literacy and Numeracy).

TIMSS[10] is an international assessment of mathematics and science that is conducted at Year 4 and Year 8 on a four-year cycle. The assessment aligns with the curricula in the participating education systems and countries, and is designed to evaluate learning in mathematics and science.

PISA[11] is an international assessment of mathematics, science and reading that is conducted with 15-year-olds on a three-year cycle. The assessment measures how well students use their knowledge and skills to meet real life opportunities and challenges.

NAP – Science literacy[12] is an Australian assessment of science literacy (knowledge, understandings and skills) of Year 6 students on a three-year cycle.

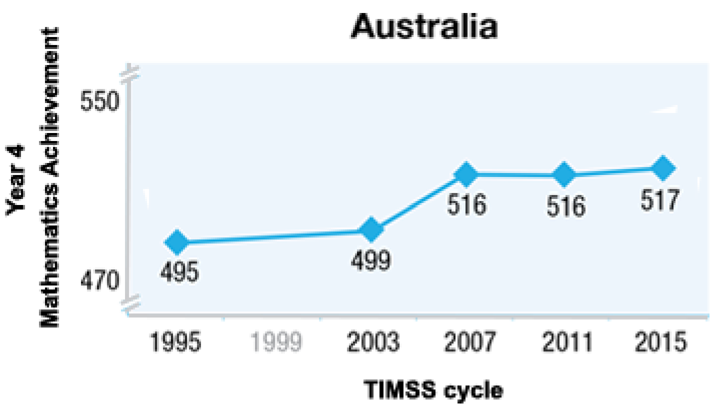
NAP – ICT literacy[13] is an Australian assessment of ICT literacy (the ability of individuals to use ICT appropriately to access, manage, integrate and evaluate information, develop new understandings, and communicate with others in order to participate effectively in society) of Year 6 and Year 10 students on a three-year cycle.

NAPLAN[14] is an Australian assessment of numeracy and literacy of Years 3, 5, 7 and 9 students on an annual basis. The assessments broadly reflect aspects of numeracy within the curriculum in all jurisdictions.

Mathematics

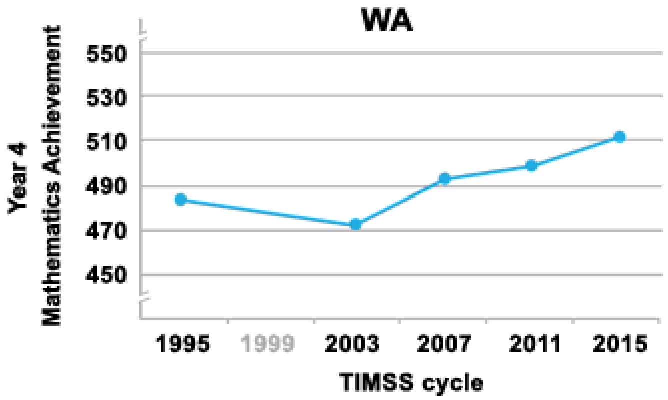
In the **2015 TIMSS Year 4** assessment, Australia was ranked in the middle, with 21 countries/regions achieving above us, seven about the same, and 20 below. The highest performing countries were Singapore, Hong Kong (China) and Korea, but Australia was also outperformed by culturally similar countries, such as England and the United States. Australia's absolute performance has been stagnant since 2007, but our relative performance has declined. Nine percent of Australian students met the 'advanced' international benchmark, and 70% met the 'intermediate' international benchmark which is our national proficient standard. There is a substantial 'tail' in Australian students' performance with 30% not meeting the proficient standard.

Figure 2: TIMSS Australian Year 4 Mathematics Achievement



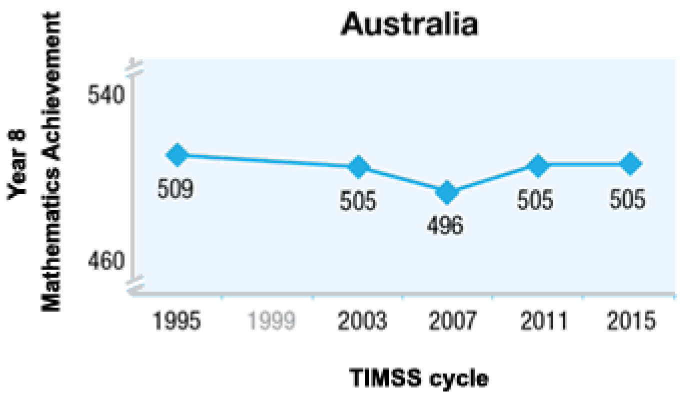
In 2015, the mean score of Western Australian students (512) was similar to the Australian mean (517). Encouragingly, WA's mean score has increased gradually from 472 to 512 since 2003. Ten percent of Western Australian students met the 'advanced' international benchmark, but 37% did not meet the proficient standard.

Figure 3: TIMSS Western Australian Year 4 Mathematics Achievement



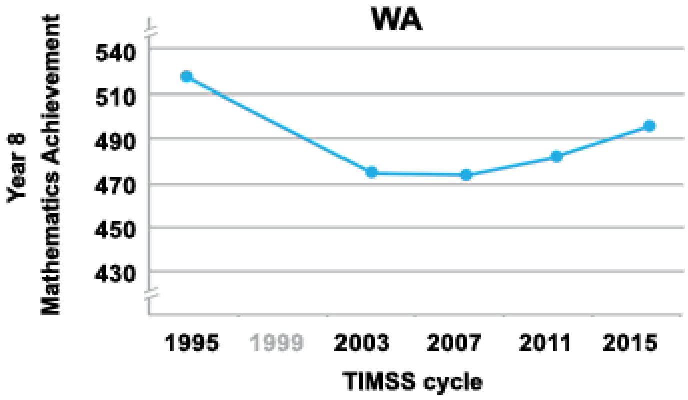
In the **2015 TIMSS Year 8** assessment, Australia was ranked in the upper middle, with 12 countries/regions achieving above us, five about the same, and 21 below. The highest performing countries were Singapore, Korea and Chinese Taipei, but Australia was also outperformed by culturally similar countries such as Canada, England and the United States. Seven percent of Australian students met the 'advanced' international benchmark, and 64% met the 'intermediate' international benchmark which is our national proficient standard. Again, there is a substantial 'tail' in Australian students' performance with 36% not meeting the proficient standard.

Figure 4: TIMSS Australian Year 8 Mathematics Achievement



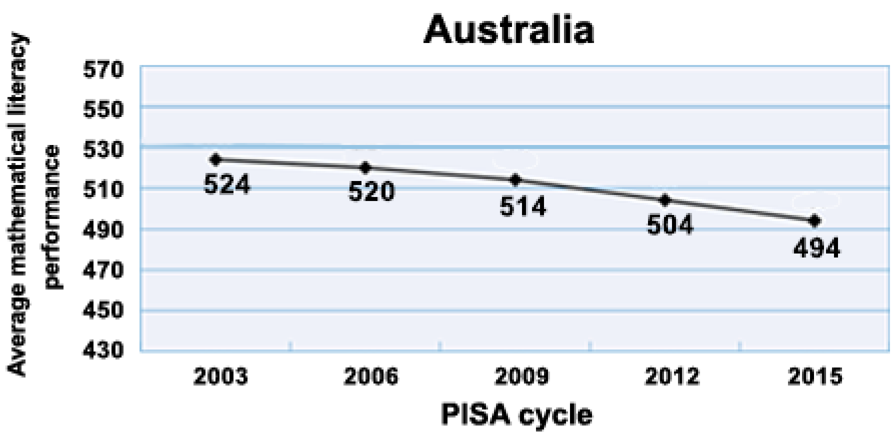
In 2015, the mean score of Western Australian students (508) was similar to the Australian mean (505). WA's mean score has increased from 485 to 508 since 2007. Eight percent of Western Australian students met the 'advanced' international benchmark, but 36% did not meet the proficient standard.

Figure 5: TIMSS Western Australian Year 8 Mathematics Achievement



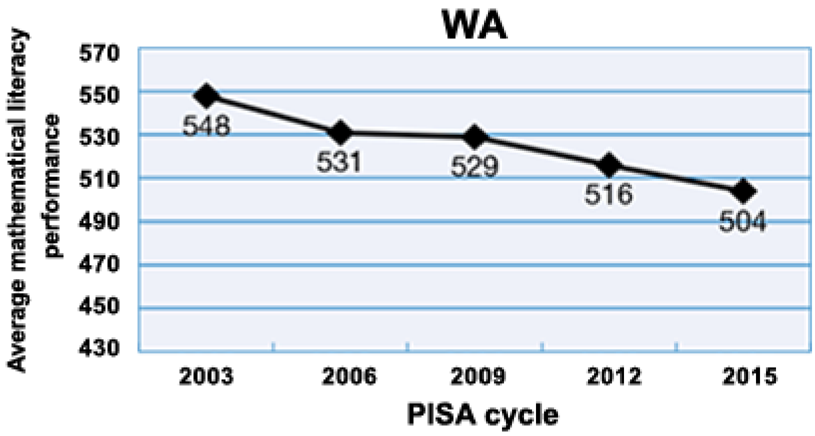
In the **2015 PISA 15-year-olds'** assessment, Australia was ranked in the middle, with 19 countries/regions achieving above us, 10 about the same, and 25 below. The highest performing countries were Singapore, Hong Kong (China) and Macao (China). Australia was outperformed by Canada and Ireland, comparable with the United Kingdom and New Zealand, and higher than the United States. Australia's absolute performance has declined from a mean score of 524 in 2003 to 494 in 2015. The mean score for the Organisation for Economic Cooperation and Development (OECD) countries in 2015 was 490. Eleven percent of Australian students met the 'highly' proficient standard, 55% met the national proficient standard and 22% were classed as 'low' performers. Since 2003, the percentage of low performers has increased from 14% to 22% and the percentage of high achievers has decreased from 20% to 11%.

Figure 6: PISA Australian 15-year-olds' Mathematics Achievement



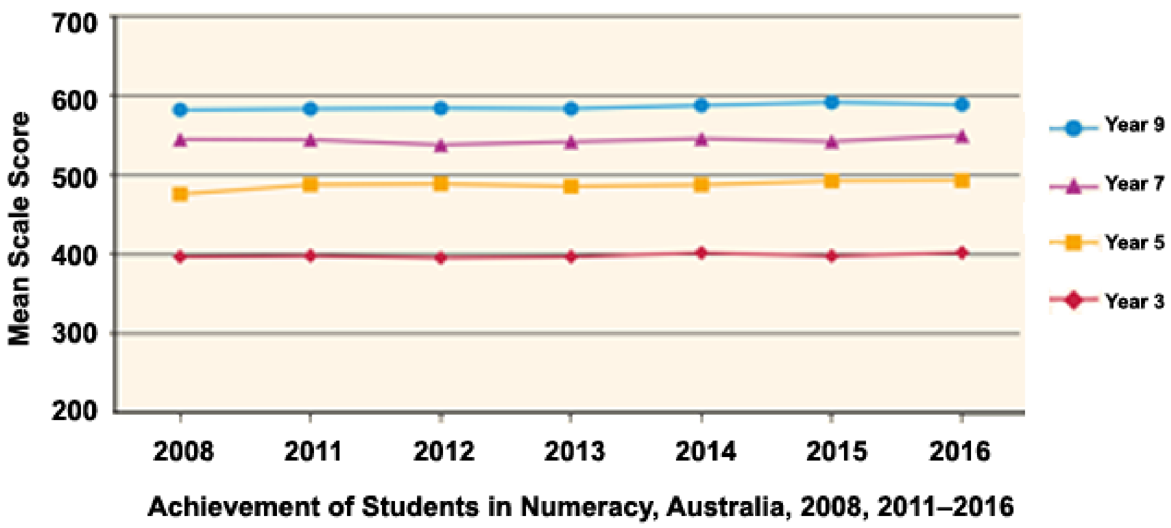
In 2015, the mean score of Western Australian students (504) was higher than the Australian mean (494), with WA, Victoria (VIC) and the Australian Capital Territory (ACT) achieving at statistically similar levels. However, WA's mean score has decreased gradually from 548 to 504 since 2003. Since 2003, the percentage of low performers has increased from 8% to 18% and the percentage of high achievers has decreased from 28% to 12%.

Figure 7: PISA Western Australian 15-year-olds' Mathematics Achievement



National trends in the mean scores achieved in the NAPLAN – Numeracy assessment shown in Figure 8 indicate that there has been no significant change in achievement from 2008 to 2016, with the exception of Year 5.

Figure 8: NAPLAN Australian Numeracy Achievement



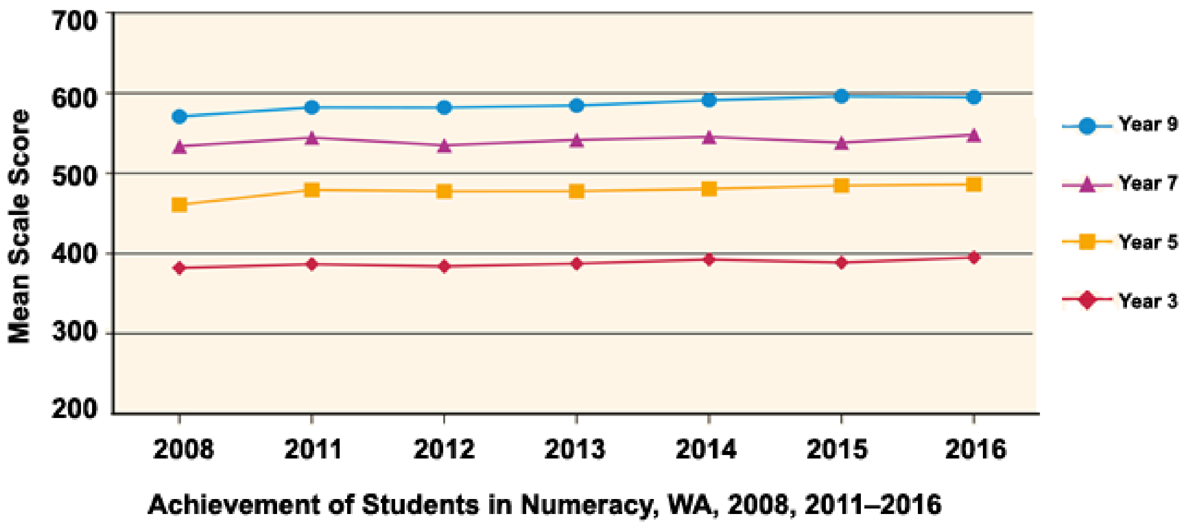
The mean scores for Western Australian students in 2016 are not significantly different from national mean scores, as shown in Table one.

Table 1

Year	WA mean	National mean	WA percentage meeting minimum standard	National percentage meeting minimum standard
Year 3	395	402	95	96
Year 5	486	493	93	94
Year 7	548	550	95	96
Year 9	595	589	96	95

However, the trend data for Western Australian (Figure 9) indicate significant gains from 2008 to 2016 for Years 5, 7 and 9.

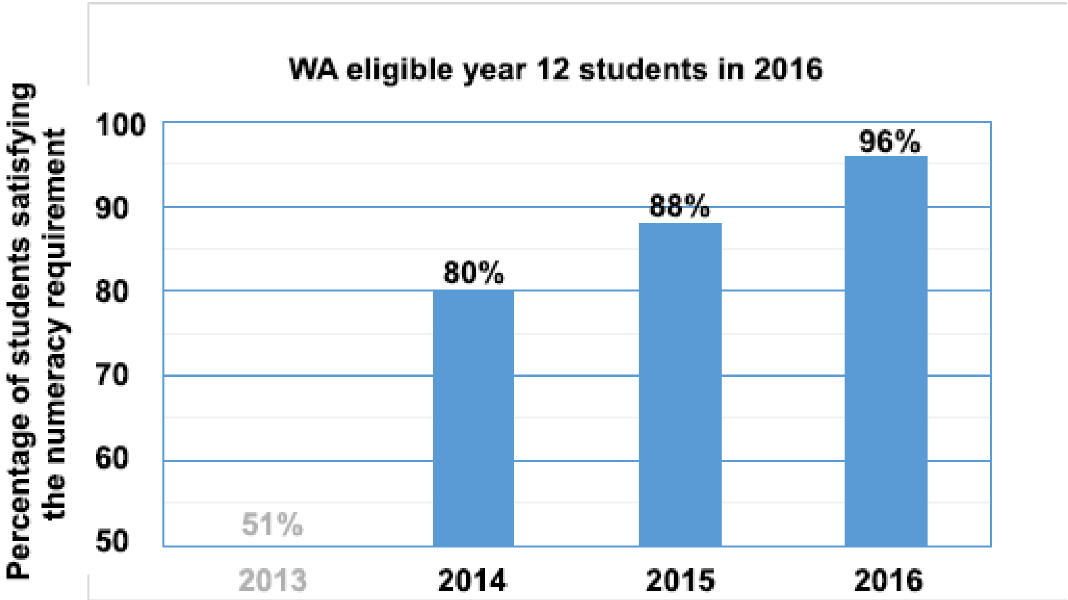
Figure 9: NAPLAN Western Australian Numeracy Achievement



From 2016, the School Curriculum and Standards Authority introduced a requirement for Year 12 Western Australian students to demonstrate a minimum level of numeracy and literacy to achieve a Western Australian Certificate of Education. The minimum level was set at Level 3 in the Australian Core Standards Framework. Students could demonstrate this through achievement of Band 8 or higher in their Year 9 NAPLAN assessment or by sitting the Online Literacy and Numeracy Assessment (OLNA) in Years 10–12.

For the 2016 Year 12 cohort, 51% of eligible students qualified on the basis of their Year 9 NAPLAN results, but by the end of 2016 96% of students had demonstrated the required standard. The increase in the percentages of students achieving the standard over the 2014–16 period is shown in Figure 10.

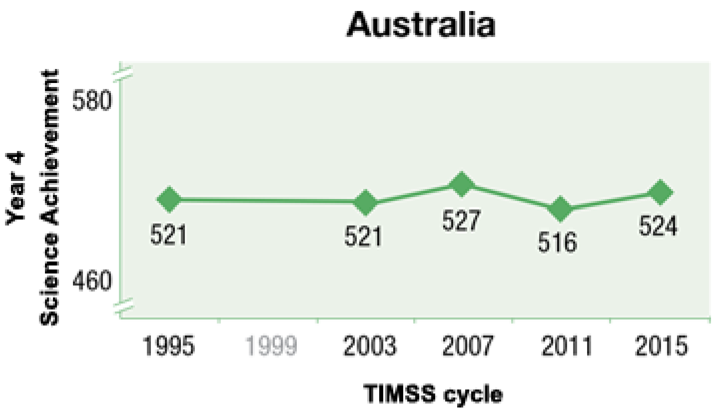
Figure 10: Percentage of Western Australian students (Year 12, 2016 cohort) satisfying the WACE numeracy requirement



Science

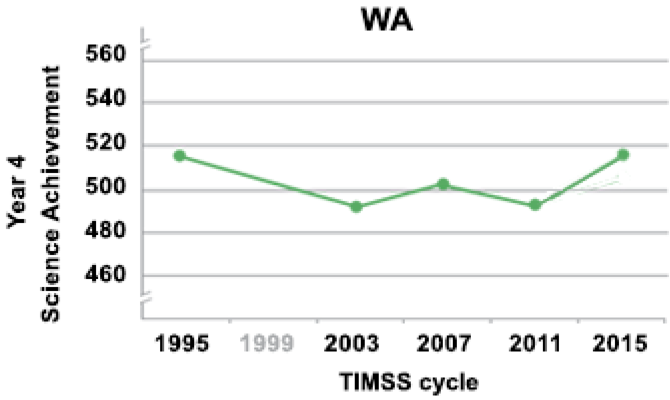
In the **2015 TIMSS Year 4** assessment, Australia was ranked in the middle, with 17 countries/regions achieving above us, 12 about the same, and 17 below. The highest performing countries were Singapore, Korea and Japan, but Australia was also outperformed by culturally similar countries such as the United States and England. Australia's absolute performance has been stagnant since 1995. Eight percent of Australian students met the 'advanced' international benchmark and 75% met the 'intermediate' international benchmark which is our national proficient standard. There is a substantial 'tail' in Australian students' performance with 25% not meeting the proficient standard.

Figure 11: TIMSS Australian Year 4 Science Achievement



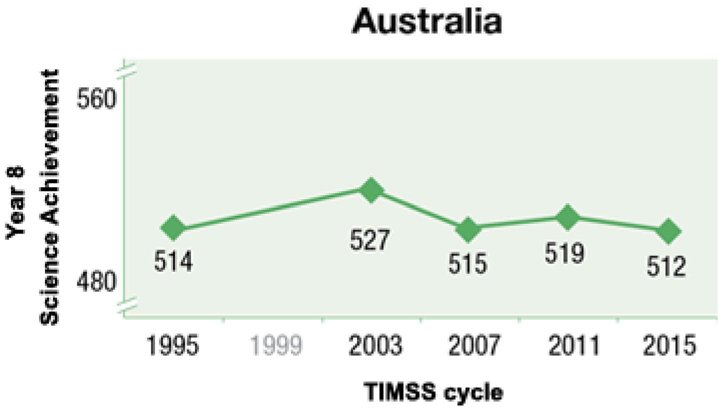
In 2015, the mean score of Western Australian students (516) was lower than the Australian mean (524) although not significantly different from other jurisdictions except the ACT. WA's mean score has been essentially stagnant since 2003. Nine percent of Western Australian students met the 'advanced' international benchmark, but 30% did not meet the proficient standard.

Figure 12: TIMSS Western Australian Year 4 Science Achievement



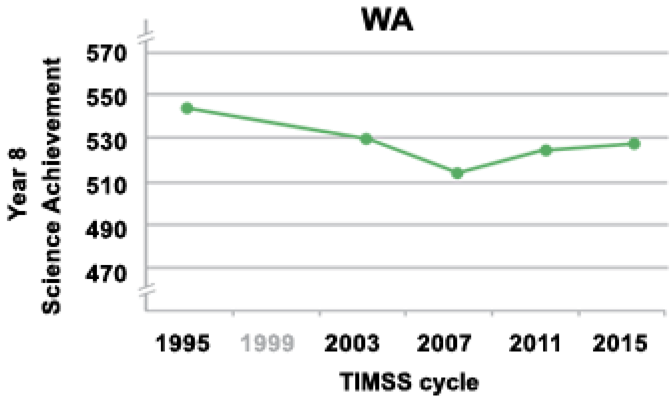
In the **2015 TIMSS Year 8** assessment, Australia was ranked in the upper middle, with 14 countries/regions achieving above us, four about the same, and 20 below. The highest performing countries were Singapore, Japan and Chinese Taipei, but Australia was also outperformed by culturally similar countries such as England, the United States and Canada. Australia's absolute performance has been stagnant since 1995. Seven percent of Australian students met the 'advanced' international benchmark and 69% met the 'intermediate' international benchmark which is our national proficient standard. Again, there is a substantial 'tail' in Australian students' performance with 31% not meeting the proficient standard.

Figure 13: TIMSS Australian Year 8 Science Achievement



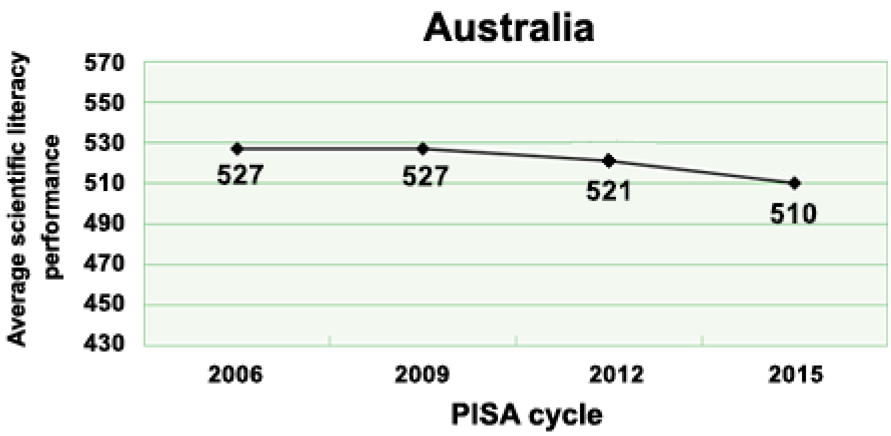
In 2015, the mean score of Western Australian students (518) was equal second highest of the Australian jurisdictions (Australian mean of 512) although not significantly different from other jurisdictions. WA again had a significant 'tail' in performance with 30% of students not reaching the proficiency standard.

Figure 14: TIMSS Western Australian Year 8 Science Achievement



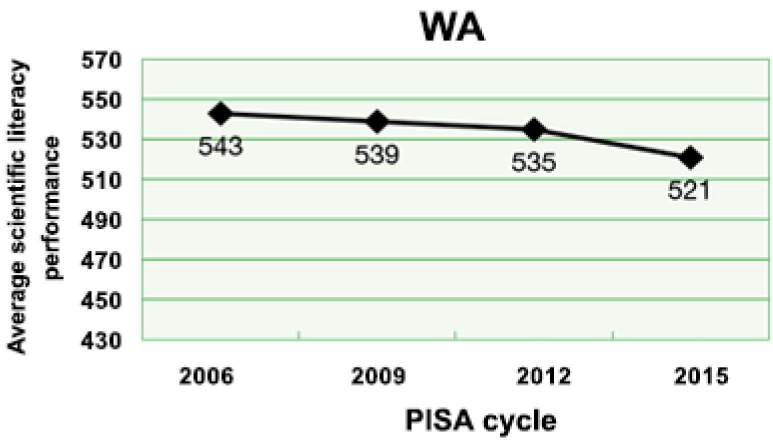
In the **2015 PISA 15-year-olds'** assessment, Australia was ranked in the top quartile, with nine countries/regions achieving above us, eight about the same, and 39 below. The highest performing countries were Singapore, Japan and Estonia. Australia was outperformed by Canada, comparable with New Zealand and the United Kingdom, and higher than the United States. Australia's absolute performance has declined from a mean score of 527 in 2006 to 510 in 2015. The mean score for the OECD countries in 2015 was 493. 11% of Australian students met the 'highly' proficient standard, 61% met the national proficient standard and 18% were classed as 'low' performers. Since 2003, the percentage of low performers has increased from 13% to 18% and the percentage of high achievers has decreased from 14% to 11%.

Figure 15: PISA Australian 15-year-olds' Science Achievement



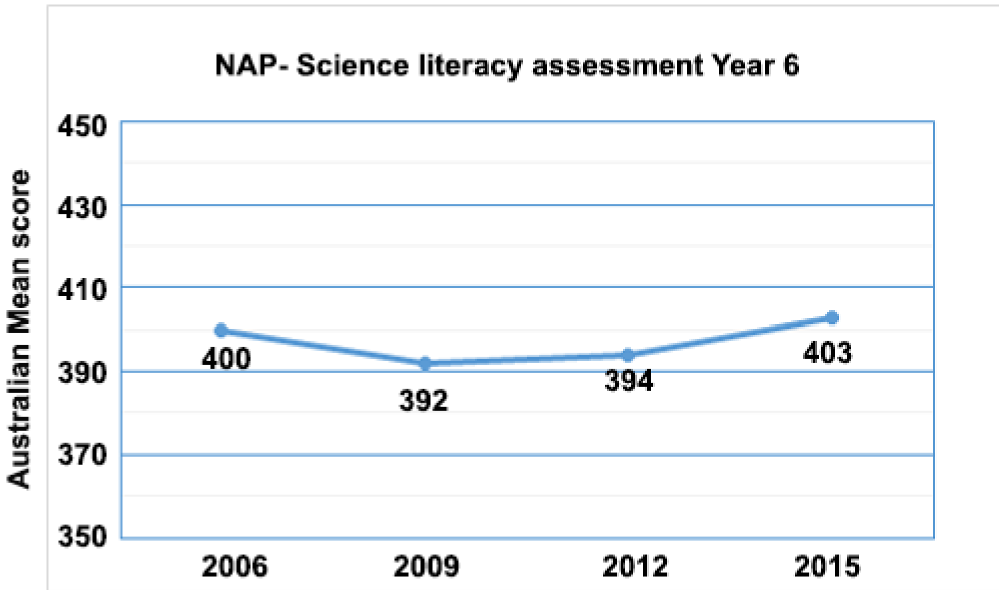
In 2015, the mean score of Western Australian students (521) was higher than the Australian mean (510) and all jurisdictions except the ACT. However, WA's mean score has decreased from 543 to 521 since 2006. Since 2006, the percentage of high performers has fallen from 19% to 12% and the percentage of low achievers has increased from 10% to 15%.

Figure 16: PISA Western Australian 15-year-olds' Science Achievement



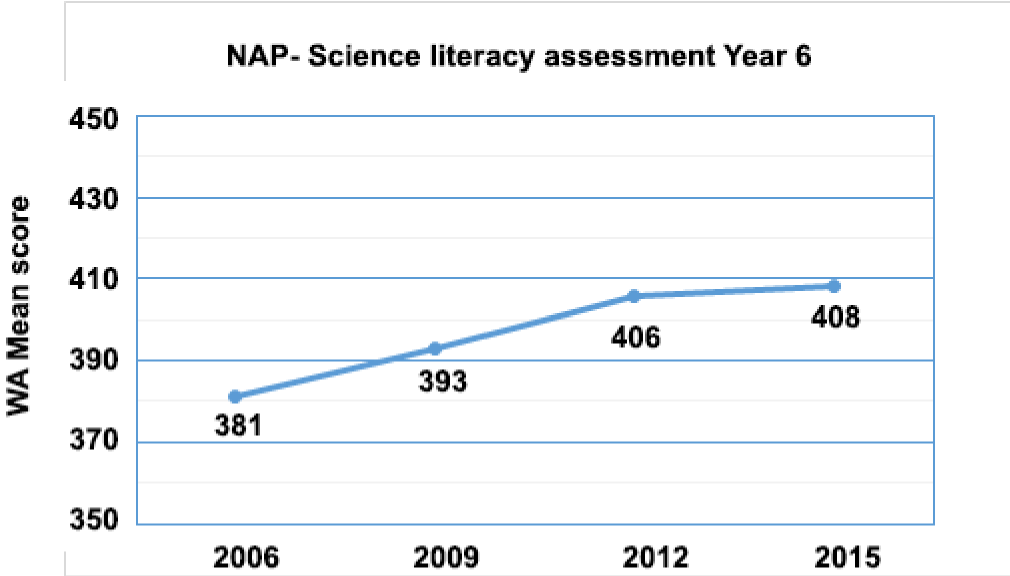
In the 2015 Year 6 **NAP – Science Literacy assessment**, the national mean achievement score of 403 did not differ significantly from previous assessments in 2006, 2009 and 2012. Nationally, 55% of students achieved at or above the proficient standard in 2015, which was also comparable to previous assessments.

Figure 17: NAP Australian Year 6 Science Literacy Achievement



In 2015, the Western Australian students' mean achievement score of 408 was comparable with other jurisdictions and maintained the gains achieved between 2006 (mean of 381) and 2012 (mean of 406). In 2015, 58% of Western Australian students achieved at or above the proficient standard, which was significantly above the level achieved in 2006 (47%).

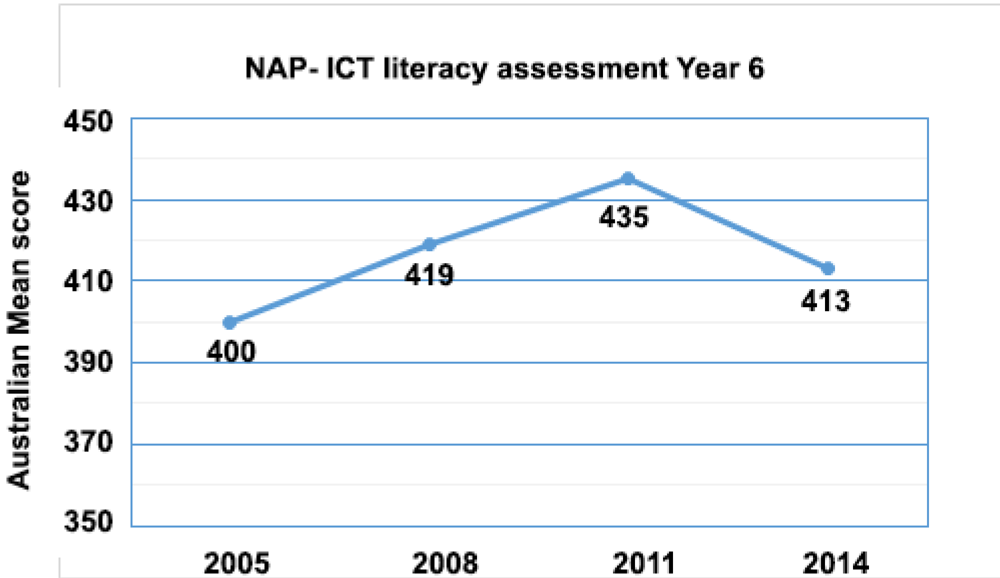
Figure 18: NAP Western Australian Year 6 Science Literacy Achievement



Information and communications technology

In the 2014 **NAP – ICT literacy assessment**, the Year 6 national mean achievement score of 413 was significantly lower than that achieved in 2011 (435), but comparable with 2005 and 2008 assessments. Nationally, 55% of students achieved at or above the proficient standard in 2014, which was also lower than in 2011 (62%).

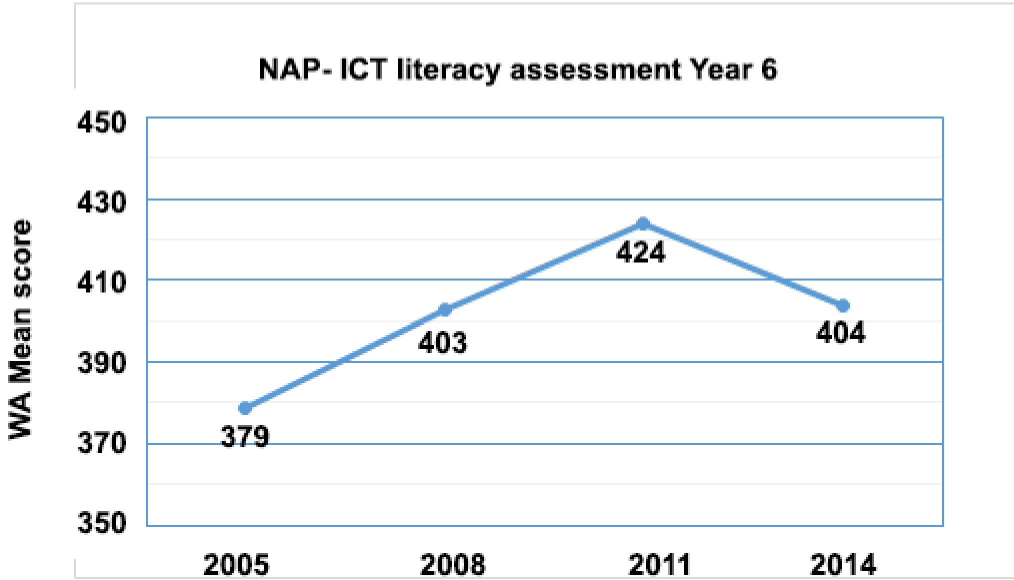
Figure 19: NAP Australian Year 6 ICT Literacy Achievement



In 2014, Year 6 Western Australian students' mean achievement score of 404 was comparable with other jurisdictions, but lower than the mean score of 424 in 2011. In 2014, 52% of Western

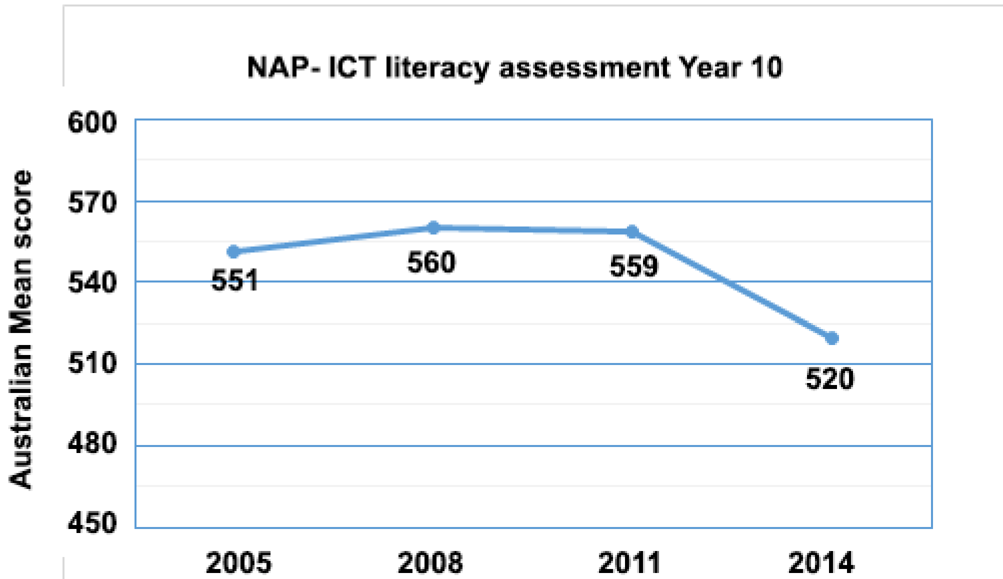
Australian students achieved at or above the proficient standard, which was significantly below the level achieved in 2011 (59%).

Figure 20: NAP Western Australian Year 6 ICT Literacy Achievement



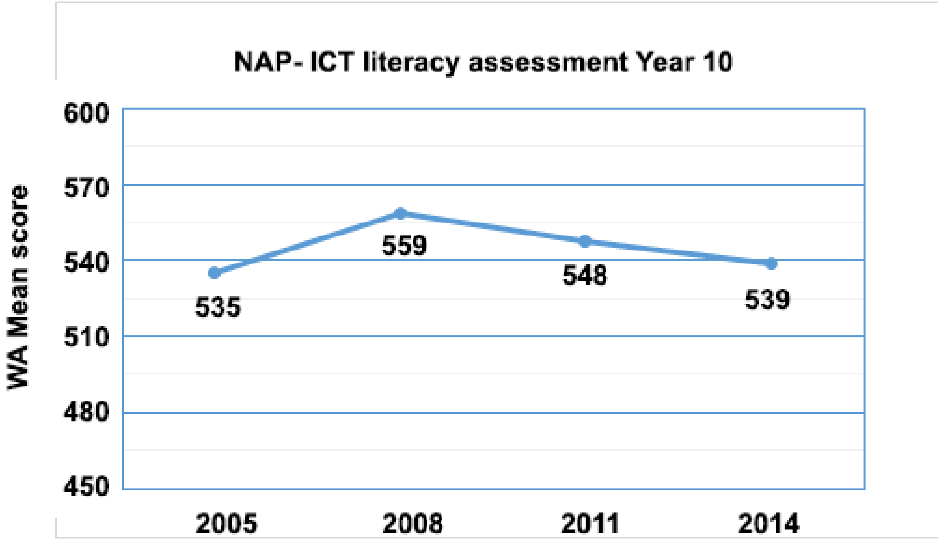
In 2014, the Year 10 national mean achievement score of 520 was significantly lower than that achieved in 2011 (559), and lower than in previous assessments. Nationally, 52% of students achieved at or above the proficient standard in 2014, which was lower than in previous assessments (65% in 2011).

Figure 21: NAP Australian Year 10 ICT Literacy Achievement



In 2014, the Year 10 Western Australian students' mean achievement score of 539 was lower than the mean score of 548 in 2011, but not significantly. In 2014, 57% of Western Australian students achieved at or above the proficient standard, which was also below the level achieved in 2008 (65%) and 2011 (61%).

Figure 22: NAP Western Australian Year 6 ICT Literacy Achievement



Commentary

It is difficult to make generalised conclusions on Australian students' achievement in STEM from the results of internationalised assessments such as TIMSS and PISA. As Reid[16] has commented, the results are somewhat inconsistent in terms of country rankings. There are significant cultural differences between the countries and regions that participate in these assessments, and there are possible issues regarding the methodology and administration of these assessments in different settings. He also comments that students from countries that score highest on the test results sometimes demonstrate low levels of interest in science or in pursuing scientific careers.

The results of the international tests generally place Australia around the middle (TIMSS) or higher (PISA) on the list of participating countries. However, the results suggest that Australia's performance in absolute terms is stagnating and that Australia is slipping in terms of international rankings. **While media commentary often overstates the current situation as a crisis in STEM education in this country, there is little doubt that there is room for considerable improvement in our performance.**

Australia's Chief Scientist Alan Finkel[7] states that while international testing cannot capture everything of importance in Australian education we should take the results seriously. He emphasises that as a 'first-class country, with a prosperous economy and an egalitarian spirit' we 'must not be fair-to-middling when it comes to science and maths in school'.

Singapore is often heralded as achieving excellence in these international assessments. Some aspects of the Singaporean system are admirable, such as their commitment to promote educational excellence, recruit high quality teachers and invest in professional development of their workforce. However, less attractive features of their system are a hypercompetitive environment, high anxiety for students, and a massive private tutor/coaching colleges industry. Reid[16] and Wise[17] both caution against adopting all aspects of the Singaporean system. Reid quotes the international educationist Yong Zhao as saying that ‘many educators in these “top” countries are concerned about the ways in which the testing culture is beginning to narrow the curriculum and place extreme pressure on students to perform as after-hours “cramming” schools become the norm’.

One aspect of the international test results that has attracted the attention of several commentators[18–19] is that Australia has a long tail of student under achievement, and that socioeconomic background is an important determinant of achievement. Thomson[18] states, in relation to TIMSS, the differences in achievement are starkest in terms of socioeconomic background, Indigeneity and location. Riddle and Lingard[19] have also commented on the issue of educational inequality in Australia.

Appropriately, emphasis[20–21] has also been placed on the need to attract high quality teachers, addressing the issue of non-specialist teachers teaching out-of-field (especially in Years 7–10), and enhancing the effectiveness of classroom teaching.[22–23] As has often been stated – ‘the teacher is the key’.

What do we want to achieve?

If we are to improve Australian and Western Australian students’ achievement in STEM it is clear that more needs to be done.

In WA, some recent initiatives are currently in place. The STEM Learning Project[24], an initiative funded by the Department of Education, involving the Mathematical Association of WA Inc., the Science Teachers Association of WA, the Educational Computing Association of WA and Scitech, will deliver a range of innovative Western Australian curriculum resources to generate students’ interest, enjoyment and engagement with STEM across Years K–12.

STEM education has also benefited from the establishment of the Governor’s STEM Awards.[25] These awards were established in 2015 to recognise the support and commitment of school principals and leadership teams in developing their schools' STEM education programs. The awards aim to raise awareness of the importance of STEM education among school leadership, and incentivise them to support their teachers in undertaking STEM initiatives.

To further progress achievement of a STEM agenda in schools the following objectives summarise a possible way forward.

- Create a strong profile for STEM and establish a school culture where the importance of STEM is recognised and valued – including a whole-of-school collaborative effort. (Please note: STEM is NOT a new or separate subject – the mandated curriculum in STEM subjects is already articulated in the Western Australian Curriculum).
- Increase student participation in STEM subjects, both in overall terms and in the selection of 'difficult' options.
- Provide opportunities and support for students in low socioeconomic situations, and increase student aspirations.
- Provide learning opportunities that support both the development of knowledge and the acquisition of higher order skills such as problem solving, quantitative skills, critical thinking and communication skills.
- Attract and retain high calibre STEM teachers.
- Provide professional development opportunities for teachers in STEM content knowledge, and pedagogical content knowledge.
- Encourage partnership and outreach programs between schools and educational/professional/community organisations.

The National STEM School Education Strategy[26] contains a similar set of objectives. While there is likely to be little disagreement regarding these objectives, more attention needs to be focussed on how these objectives could be realised. To achieve this goal will require a coordinated approach involving school systems, universities, government and the private sector.

References

[1] Office of the Chief Scientist Science. (2013). *Science, Technology, Engineering and Mathematics in the National Interest: A Strategic Approach.* Canberra. Australian Government. Retrieved from **http://www.chiefscientist.gov.au/wp-content/uploads/STEMstrategy290713FINALweb.pdf**

[2] Office of the Chief Scientist. (2014). *Science, Technology, Engineering and Mathematics: Australia's Future.* Office of the Chief Scientist. Canberra. Australian Government. Retrieved from **http://www.chiefscientist.gov.au/wp-content/uploads/STEM_AustraliasFuture_Sept2014_Web.pdf**

[3] Australian Industry Group. (2015). *Progressing STEM Skills in Australia.* Australian Industry Group. Retrieved from **http://cdn.aigroup.com.au/Reports/2015/14571_STEM_Skills_Report_Final_-.pdf**

[4] Australian Government. (2015). *Commonwealth of Australia: Vision for a Science Nation. Responding to Science, Technology, Engineering and Mathematics: Australia's Future.* Canberra. Australian Government. Retrieved from **http://www.science.gov.au/scienceGov/news/Documents/VisionForAScienceNationRespondingToSTEMAustraliasFuture.pdf**

[5] Education Council. (2015). *National STEM School Education Strategy*: *A comprehensive plan for science, technology, engineering and mathematics education in Australia.* Education Council. Retrieved from **http://www.educationcouncil.edu.au/site/DefaultSite/filesystem/documents/National%20STEM%20School%20Education%20Strategy.pdf**

[6] Hackling, M., Murcia, K., West, J., & Anderson, K. (2014). *Optimising STEM education in WA schools.* Technology and Industry Advisory Council. Joondalup, Western Australia. Retrieved from **http://www.tiac.wa.gov.au/Files/STEM_Report_Part-1_20022014.aspx**

[7] Finkel, A. (2016, December 7) Australia is very average when it comes to maths and science performance – here's what needs to change [Blog post]. The Conversation. Retrieved from **https://theconversation.com/australia-is-very-average-when-it-comes-to-maths-and-science-performance-heres-what-needs-to-change-69782**

[8] School Curriculum and Standards Authority, Government of Western Australia. (2014). WA Curriculum and Assessment Outline. Retrieved from **https://www.scsa.wa.edu.au/**

[9] Australian Curriculum, Assessment and Reporting Authority. (2017). Glossary – Terms and their explanation. Retrieved from **https://www.myschool.edu.au/AboutUs/Glossary/glossaryLink**

[10] Thomson, S., Wernert, N., O'Grady, E., & Rodrigues, S. (2016). *TIMSS 2015: A first look at Australia's results.* Melbourne. Australian Council for Educational Research (ACER). Retrieved from **http://research.acer.edu.au/cgi/viewcontent.cgi?article=1000&context=timss_2015**

[11] Thomson, S., De Bortoli, L., & Underwood, C. (2016). *PISA 2015: A first look at Australia's results.* Melbourne. Australian Council for Educational Research (ACER). Retrieved from **http://research.acer.edu.au/cgi/viewcontent.cgi?article=1021&context=ozpisa**

[12] Australian Curriculum, Assessment and Reporting Authority (ACARA). (2017). *NAP Sample Assessment Science Literacy 2015 Public Report.* Sydney. Retrieved from **https://www.nap.edu.au/docs/default-source/default-document-library/20170309-nap_sl_final.pdf?sfvrsn=2**

[13] Australian Curriculum, Assessment and Reporting Authority (ACARA). (2015). *National Assessment Program – ICT Literacy Years 6 & 10 Report 2014.* Sydney. Retrieved from **https://www.nap.edu.au/_resources/D15_8761__NAP-ICT_2014_Public_Report_Final.pdf**

[14] Australian Curriculum, Assessment and Reporting Authority (ACARA). (2016). *NAPLAN Achievement in Reading, Writing, Language Conventions and Numeracy: National Report for 2016.* Sydney. Retrieved from **http://www.nap.edu.au/docs/default-source/default-document-library/2016-naplan-national-report.pdf**

[15] Australian Government Department of Education and Training. (2017). Australian Core Skills Framework. Retrieved from **https://www.education.gov.au/australian-core-skills-framework**

[16] Reid, A. (2017, January 14). International tests don't tell us about the quality of Australian education? [Blog post]. Sydney Morning Herald. Retrieved from **http://www.smh.com.au/comment/international-tests-dont-tell-us-about-the-quality-of-australian-education-20170111-gtpxi9.html**

[17] Wise, A. (2016, December 8). Behind Singapore's PISA rankings success – and why other countries may not want to join the race [Blog post]. The Conversation. Retrieved from **https://theconversation.com/behind-singapores-pisa-rankings-success-and-why-other-countries-may-not-want-to-join-the-race-70057**

[18] Thomson, S. (2016, November 29). Australian schools continue to fall behind other countries in maths and science [Blog post]. The Conversation. Retrieved from **https://theconversation.com/australian-schools-continue-to-fall-behind-other-countries-in-maths-and-science-69341**

[19] Riddle, S. and Lingard, R. (2016, December 6). PISA results don't look good, but before we panic let's look at what we can learn from the latest test [Blog post]. The Conversation. Retrieved from **https://theconversation.com/pisa-results-dont-look-good-but-before-we-panic-lets-look-at-what-we-can-learn-from-the-latest-test-69470**

[20] Masters, G. (2016, November 29). 20-year slide in maths and science learning [Blog post]. Teacher Magazine. Retrieved from **https://www.teachermagazine.com.au/geoff-masters/article/20-year-slide-in-maths-and-science-learning**

[21] Goss, P. and Sonnemann, J. (2017). *Engaging students: Creating classrooms that improve learning.* Grattan Institute. Retrieved from **https://grattan.edu.au/wp-content/uploads/2017/02/Engaging-students-creating-classrooms-that-improve-learning.pdf**

[22] Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* Routledge. Retrieved from **https://pdfs.semanticscholar.org/2392/2d3e21a8c447bf95c18dacf630e6ce45eea3.pdf**

[23] Marzano, R. J. (2007). *The art and science of teaching: A comprehensive framework for effective instruction.* ASCD. Alexandria, Virginia USA.

[24] The STEM Learning Project. (n.d.). Retrieved from **http://stemlearning.org.au/**

[25] Government of Western Australia. (n.d.). Governor's School STEM Awards. Retrieved from **http://www.jtsi.wa.gov.au/what-we-do/science-and-innovation/science-award-programs/governor's-school-stem-awards**

[26] Education Council. (2015). *National STEM School Education Strategy*: *A comprehensive plan for science, technology, engineering and mathematics education in Australia.* Education Council. Retrieved from **http://www.educationcouncil.edu.au/site/DefaultSite/filesystem/documents/National%20STEM%20School%20Education%20Strategy.pdf**

Appendix 1

Year 12 examination enrolments in STEM subjects from 2005 to 2016 expressed as (a) the absolute number of students in the examination population, and (b) the percentage of students in the examination population, calculated as the percentage of the weighted ABS population (using the same methodology as that used by TISC). The graphs have been constructed using enrolments in former TEE subjects, former Stage 3 courses and current ATAR courses.

Graph 1a – Applied Information Technology (AIT) ATAR course linked to AIT Stage 3 course but, which cannot be linked to any TEE subjects

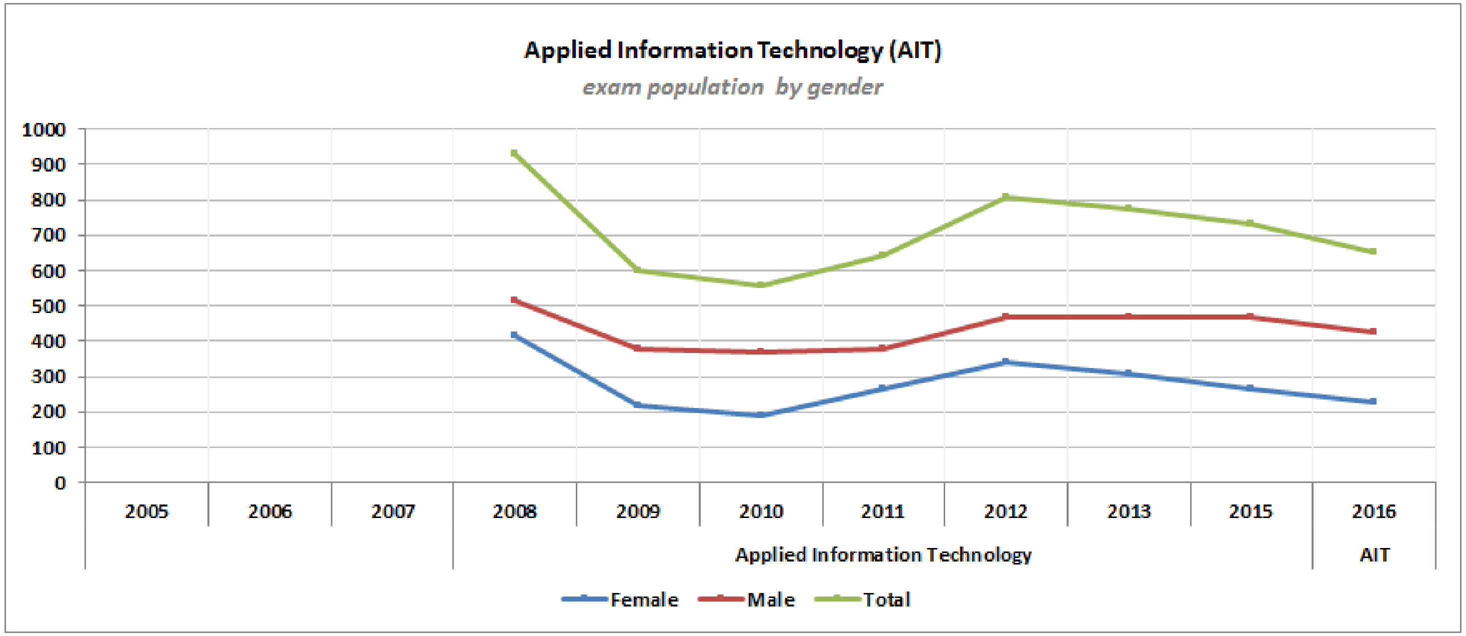


Table 1a – Number of examination candidates by gender in AIT Stage 3 course and in AIT ATAR course

				AIT	AIT3						AIT
Year	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2015***	***2016***
Female				416	219	191	264	340	309	263	226
Male				514	379	367	377	468	467	467	424
Total				**930**	**598**	**558**	**641**	**808**	**776**	**730**	**650**

Graph 1b – Applied Information Technology (AIT) ATAR course linked to AIT Stage 3 course but, which cannot be linked to any TEE subjects

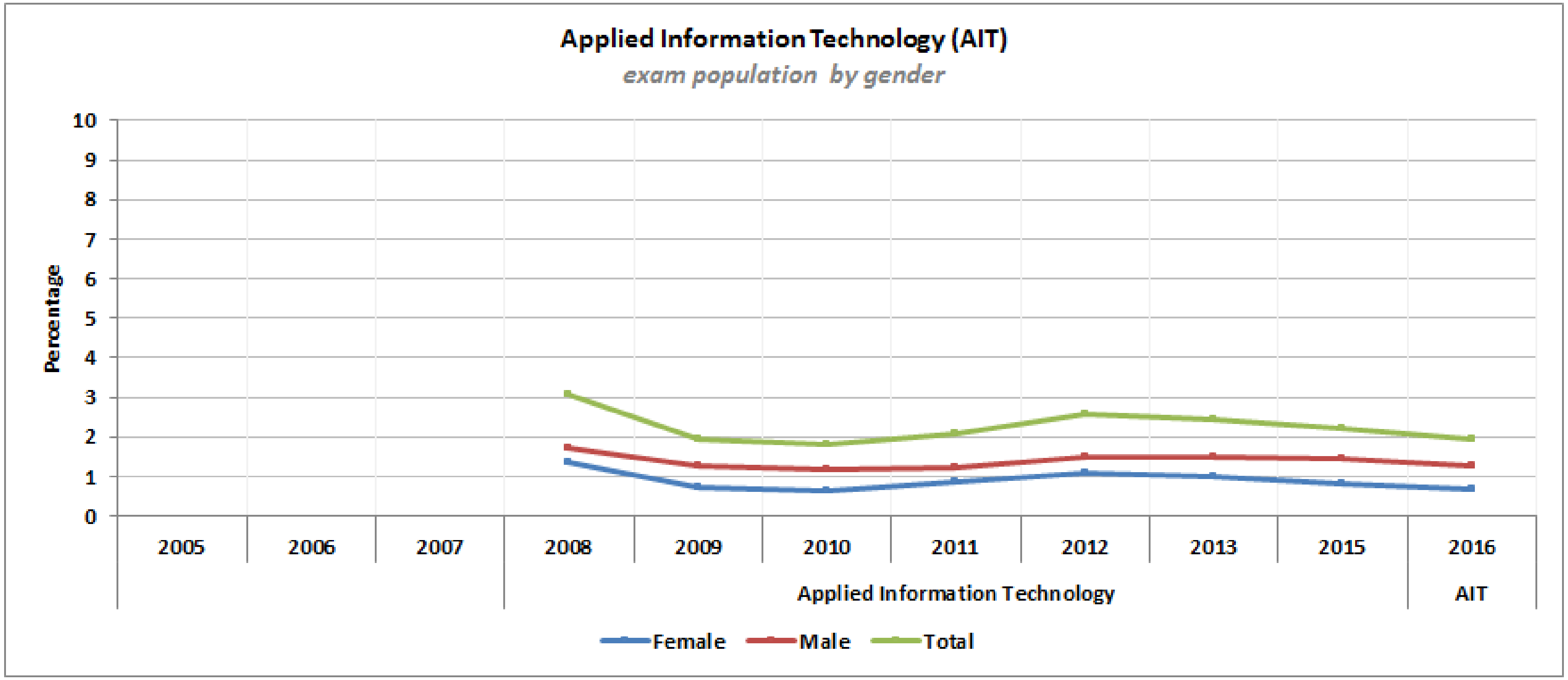


Table 1b – Examination candidates by gender in AIT Stage 3 course and AIT ATAR course

Percentages are calculated relative to weighted ABS population for that year.

				AIT	AIT3						AIT
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female				1.38	0.72	0.62	0.85	1.09	0.98	0.81	0.67
Male				1.70	1.25	1.20	1.22	1.50	1.48	1.43	1.26
Total				**3.08**	**1.97**	**1.82**	**2.07**	**2.60**	**2.45**	**2.24**	**1.93**

Graph 2a – Human Biology (HBY) ATAR course, Human Biological Science (HBS) Stage 3 course and TEE (E406) Human Biology by gender

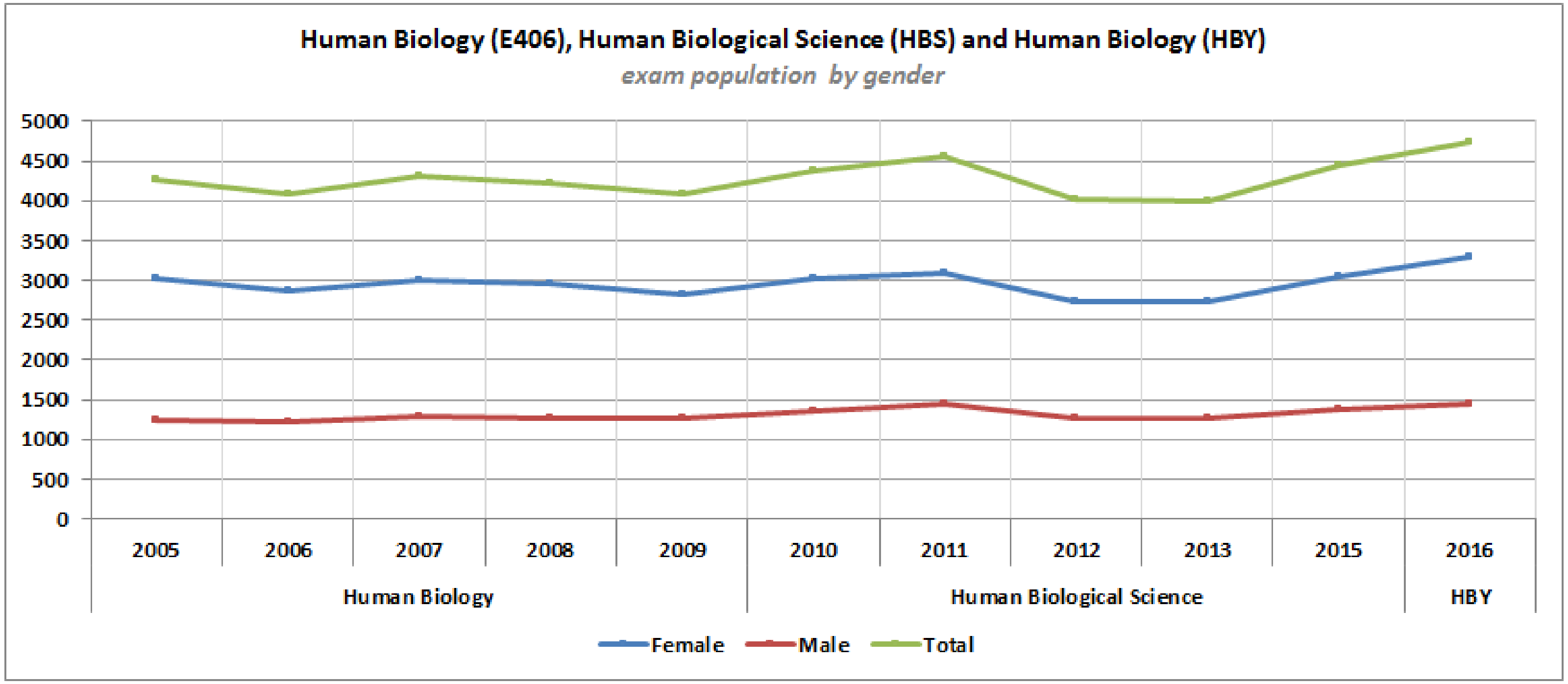


Table 2a – Number of examination candidates by gender in TEE E406 subject, HBS Stage 3 course and HBY ATAR course

Exam	Human Biology (E406)					Human Biological Science (HBS3)					HBY
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	3014	2878	3013	2959	2817	2723	2882	2737	2741	3048	3288
Male	1244	1216	1289	1270	1259	1232	1369	1278	1264	1388	1446
Total	**4258**	**4094**	**4302**	**4229**	**4076**	**3955**	**4251**	**4015**	**4005**	**4436**	**4734**

Graph 2b – Comparison of Human Biological Science (HBS) and TEE (E406) Human Biology by gender

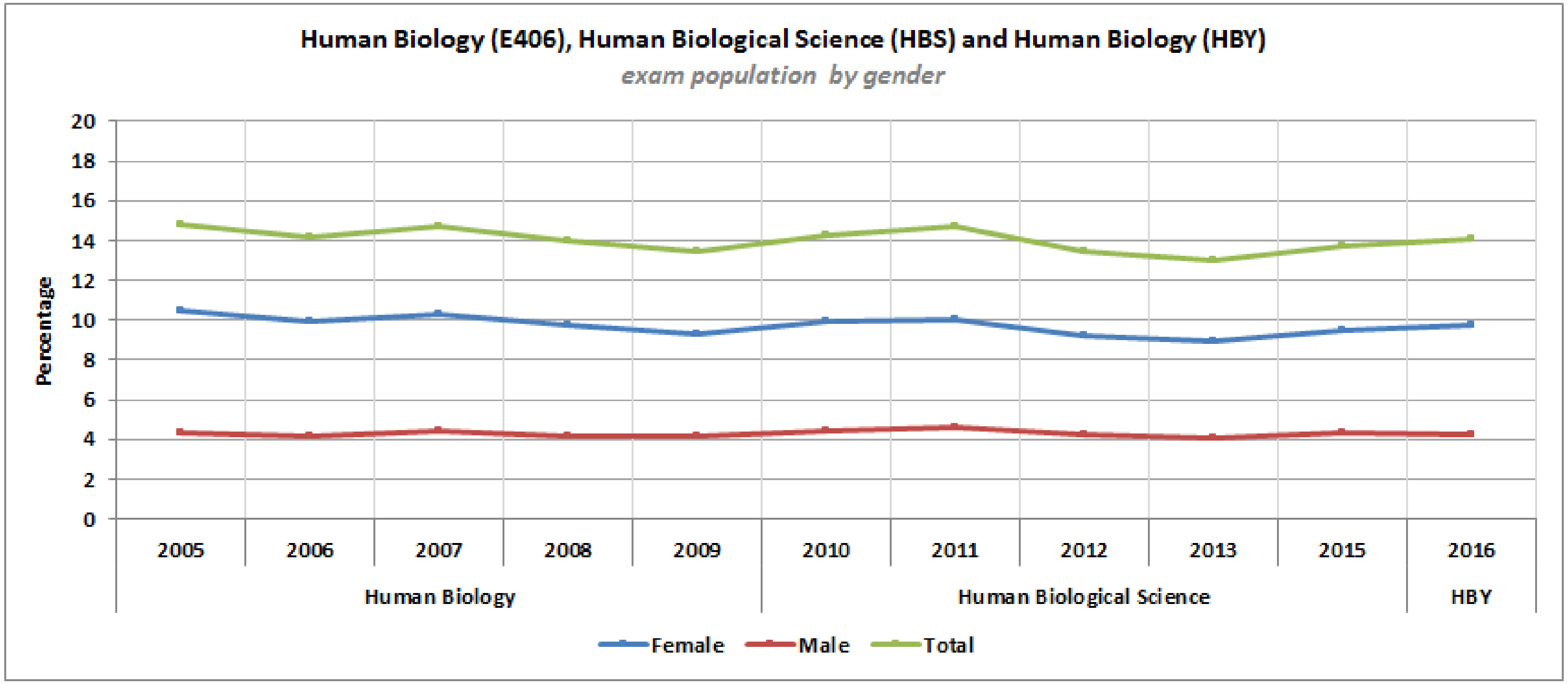


Table 2b – Examination candidates by gender in TEE E406 subject, HBS Stage 3 course and HBY ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Human Biology (E406)					Human Biological Science (HBS)					HBY
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	10.46	9.94	10.29	9.79	9.28	8.89	9.30	8.80	8.66	9.34	9.77
Male	4.32	4.20	4.40	4.20	4.15	4.02	4.42	4.11	3.99	4.25	4.30
Total	**14.77**	**14.14**	**14.7**	**13.99**	**13.42**	**12.91**	**13.71**	**12.91**	**12.65**	**13.59**	**14.07**

Graph 3a – Computer Science (CSC) (ATAR and Stage 3 course) and TEE (E238) Information Systems

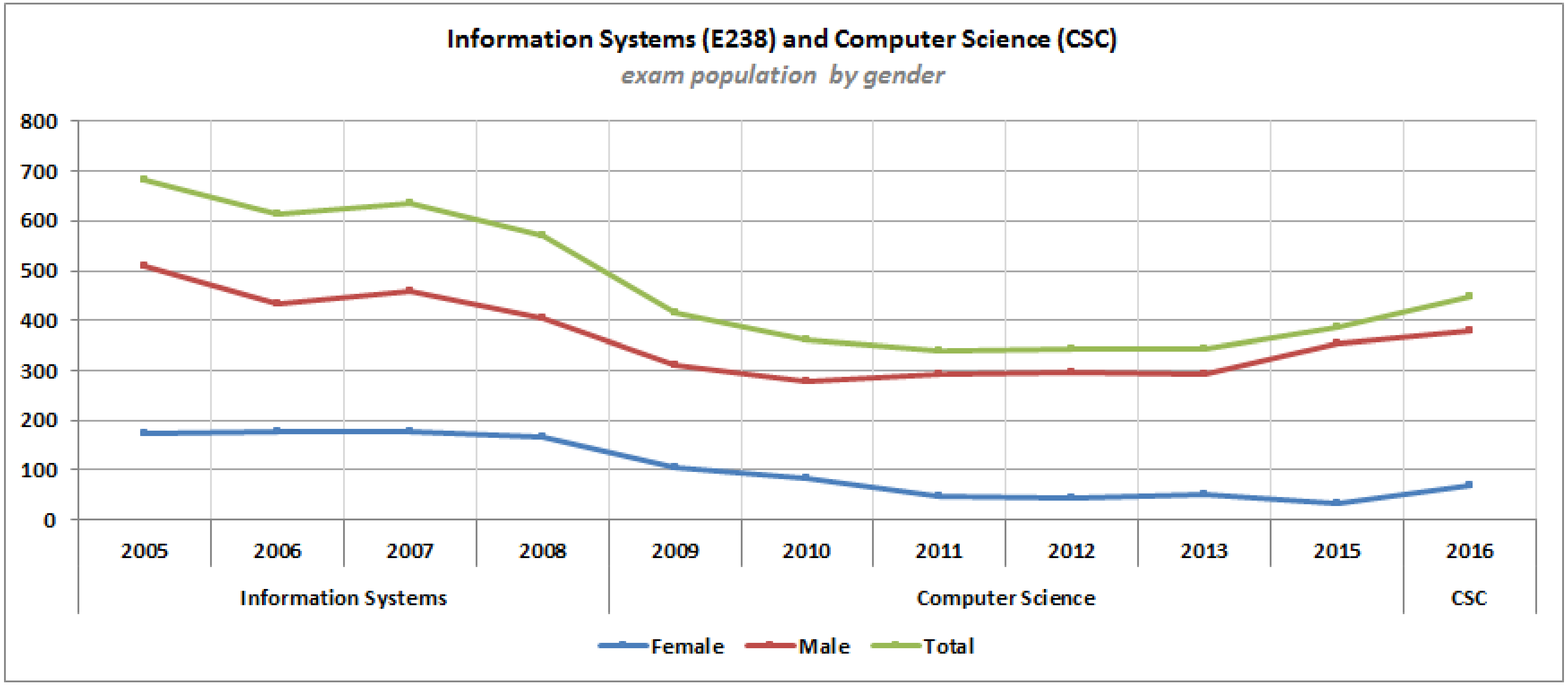


Table 3a – Number of examination candidates by gender in TEE E238 subject, CSC Stage 3 course and CSC ATAR course

Exam	**Information systems (E238)**				**Computer Science (CSC)**						**CSC**
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	173	179	178	167	105	84	49	45	51	33	70
Male	511	435	458	405	311	279	292	297	294	355	378
Total	**684**	**614**	**636**	**572**	**416**	**363**	**341**	**342**	**345**	**388**	**448**

Graph 3b – Computer Science (CSC) (ATAR and Stage 3 course) and TEE (E238) Information Systems

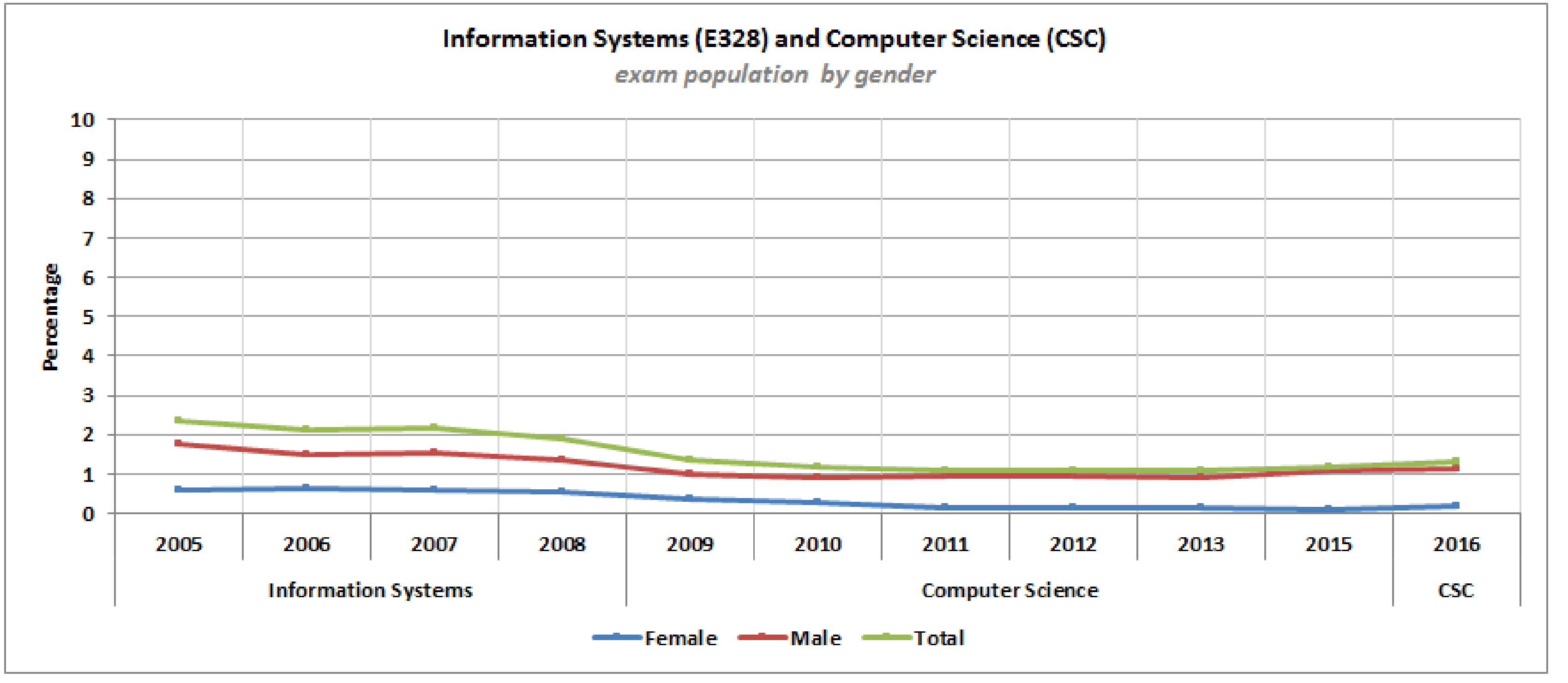


Table 3b – Examination candidates by gender in TEE E238 subject, CSC Stage 3 course and CSC ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Information systems (E238)				Computer Science (CSC)						CSC
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	0.60	0.62	0.61	0.55	0.35	0.27	0.16	0.14	0.16	0.10	0.21
Male	1.77	1.50	1.56	1.34	1.02	0.91	0.94	0.95	0.93	1.09	1.12
Total	**2.37**	**2.12**	**2.17**	**1.89**	**1.37**	**1.18**	**1.10**	**1.10**	**1.09**	**1.19**	**1.33**

Graph 4a – Biology (BLY), Biological Science (BIO) and TEE (E402) Biology

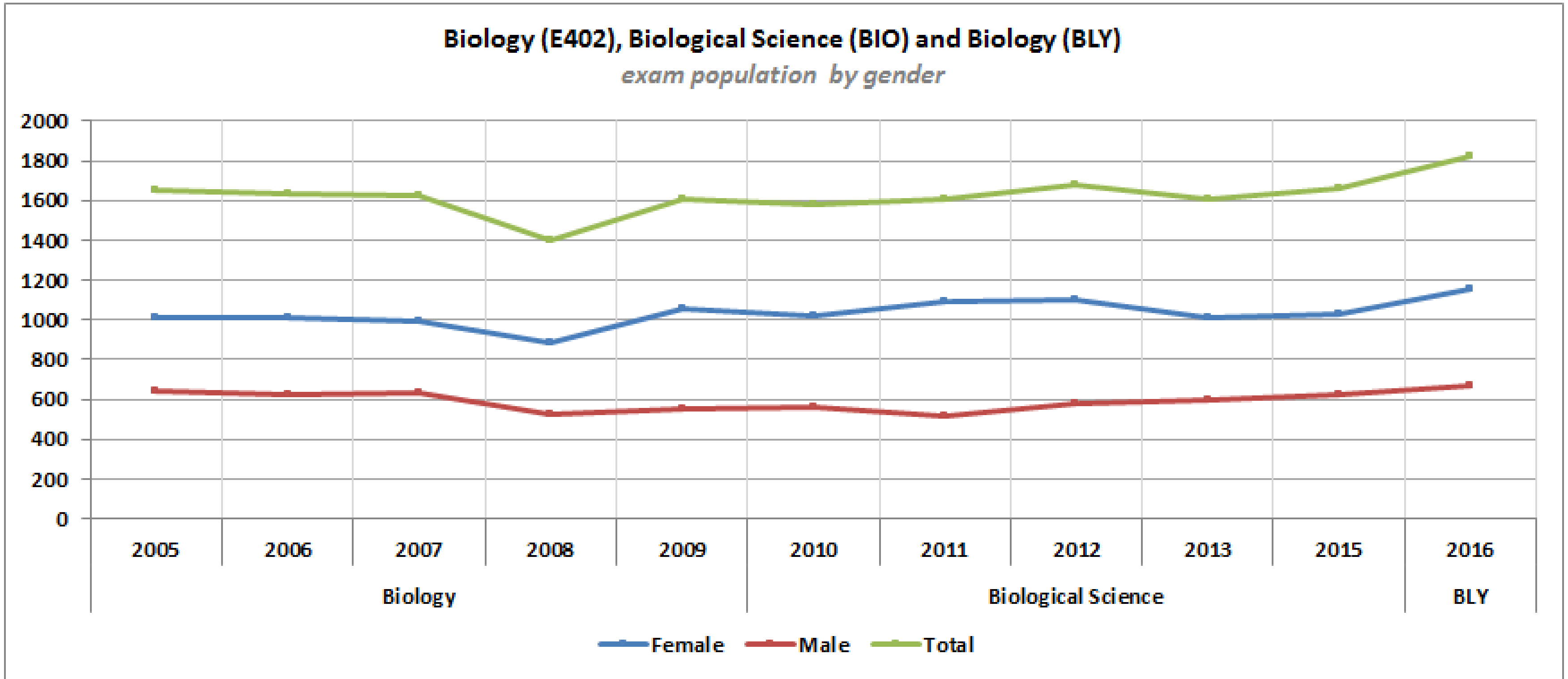


Table 4a – Number of examination candidates by gender in TEE E402 subject, BIO Stage 3 course and BLY ATAR course

Exam	Biology (E402)					Biological Science (BIO)					BLY
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	1013	1009	997	881	1056	1019	1090	1098	1016	1031	1157
Male	640	626	632	522	553	560	516	580	594	628	669
Total	**1653**	**1635**	**1629**	**1403**	**1609**	**1579**	**1606**	**1098**	**1610**	**1659**	**1826**

Graph 4b – Biology (BLY), Biological Science (BIO) and TEE (E402) Biology

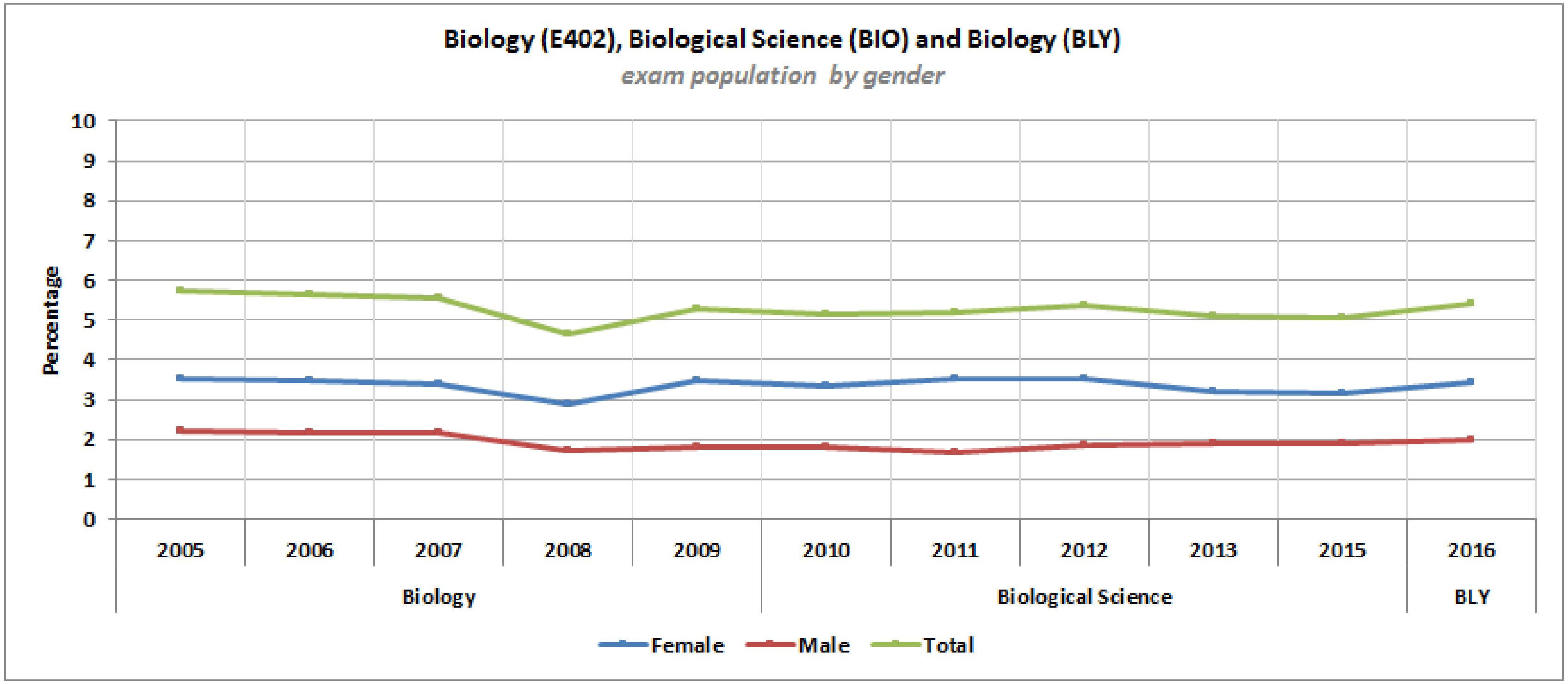


Table 4b – Examination candidates by gender in TEE E402 subject, BIO Stage 3 course and BLY ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Biology (E402)					Biological Science (BIO)					BLY
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	3.51	3.48	3.41	2.91	3.48	3.33	3.52	3.53	3.21	3.16	3.44
Male	2.22	2.16	2.16	1.73	1.82	1.83	1.66	1.86	1.88	1.92	1.99
Total	**5.74**	**5.65**	**5.56**	**4.64**	**5.30**	**5.15**	**5.18**	**5.39**	**5.09**	**5.08**	**5.43**

Graph 5a – Earth and Environmental Science (EES) and TEE (E405) Geology

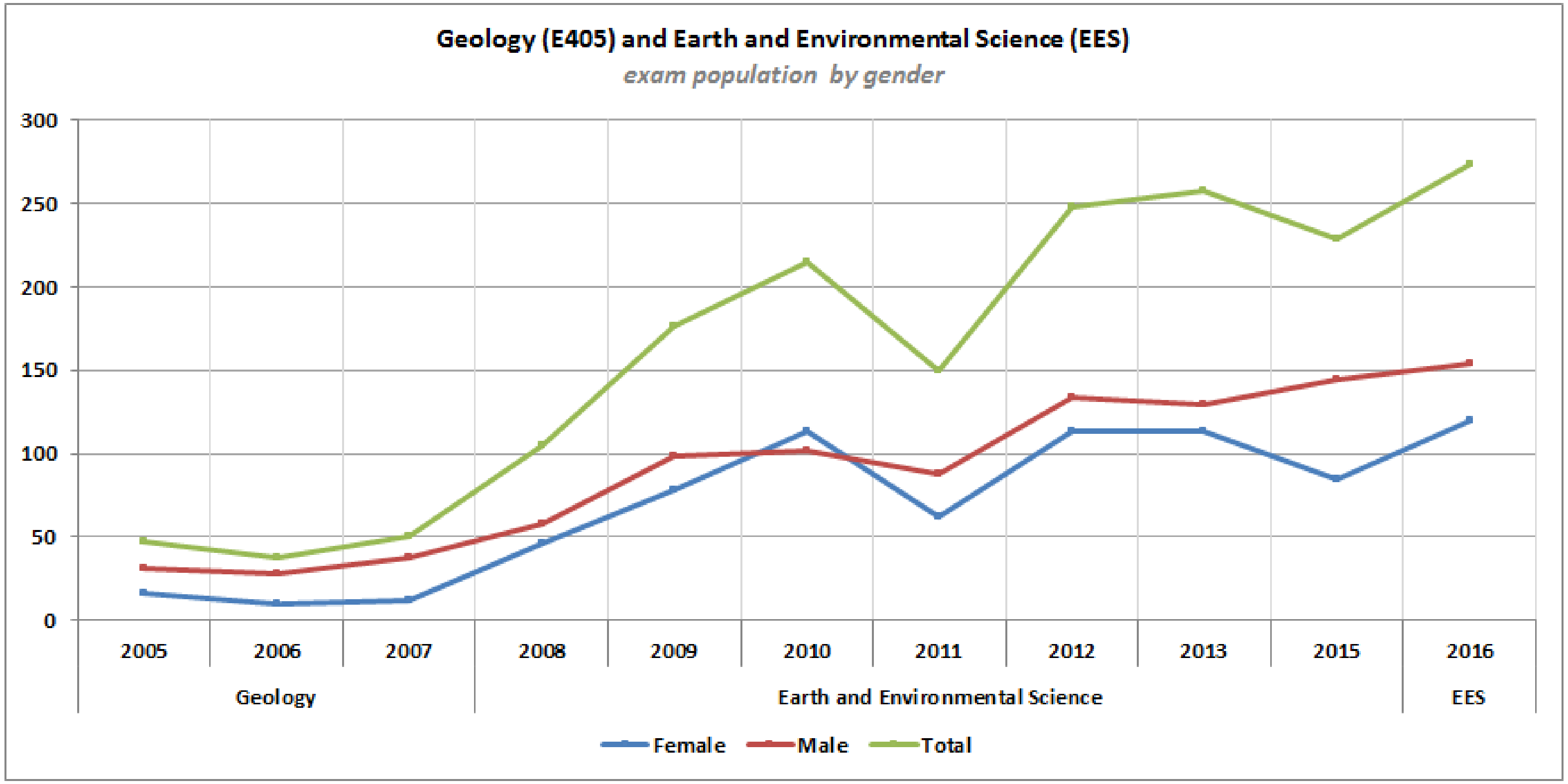


Table 5a – Number of examination candidates by gender in TEE E405 subject, EES Stage 3 course and EES ATAR course

Exam	Geology (E405)			Earth and Environmental Science (EES)							EES
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	16	10	12	46	66	113	62	114	114	85	120
Male	31	28	38	58	70	102	88	134	130	144	154
Total	**47**	**38**	**50**	**105**	**136**	**215**	**150**	**248**	**258**	**229**	**274**

Graph 5b – Earth and Environmental Science (EES) and TEE (E405) Geology

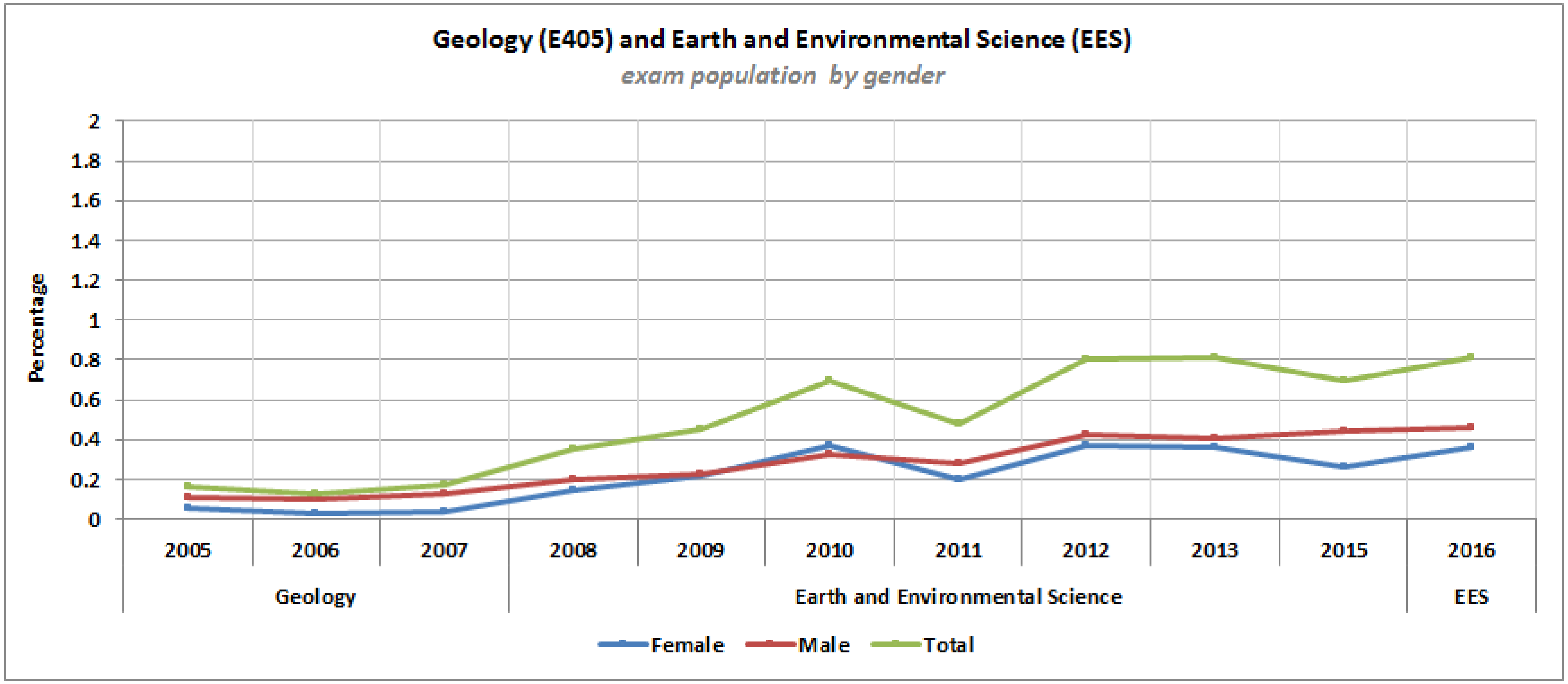


Table 5b – Examination candidates by gender in TEE E405 subject, EES Stage 3 course and EES ATAR course

Percentages are calculated relative to weighted ABS population for that year.

	Geology (E405)			Earth and Environmental Science (EES)							EES
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	0.06	0.03	0.04	0.15	0.22	0.37	0.20	0.37	0.36	0.26	0.36
Male	0.11	0.10	0.13	0.20	0.23	0.33	0.28	0.43	0.41	0.44	0.46
Total	**0.16**	**0.13**	**0.17**	**0.35**	**0.45**	**0.70**	**0.48**	**0.80**	**0.81**	**0.70**	**0.81**

Graph 6a – Integrated Science (ISC) and TEE (E408) Physical Science

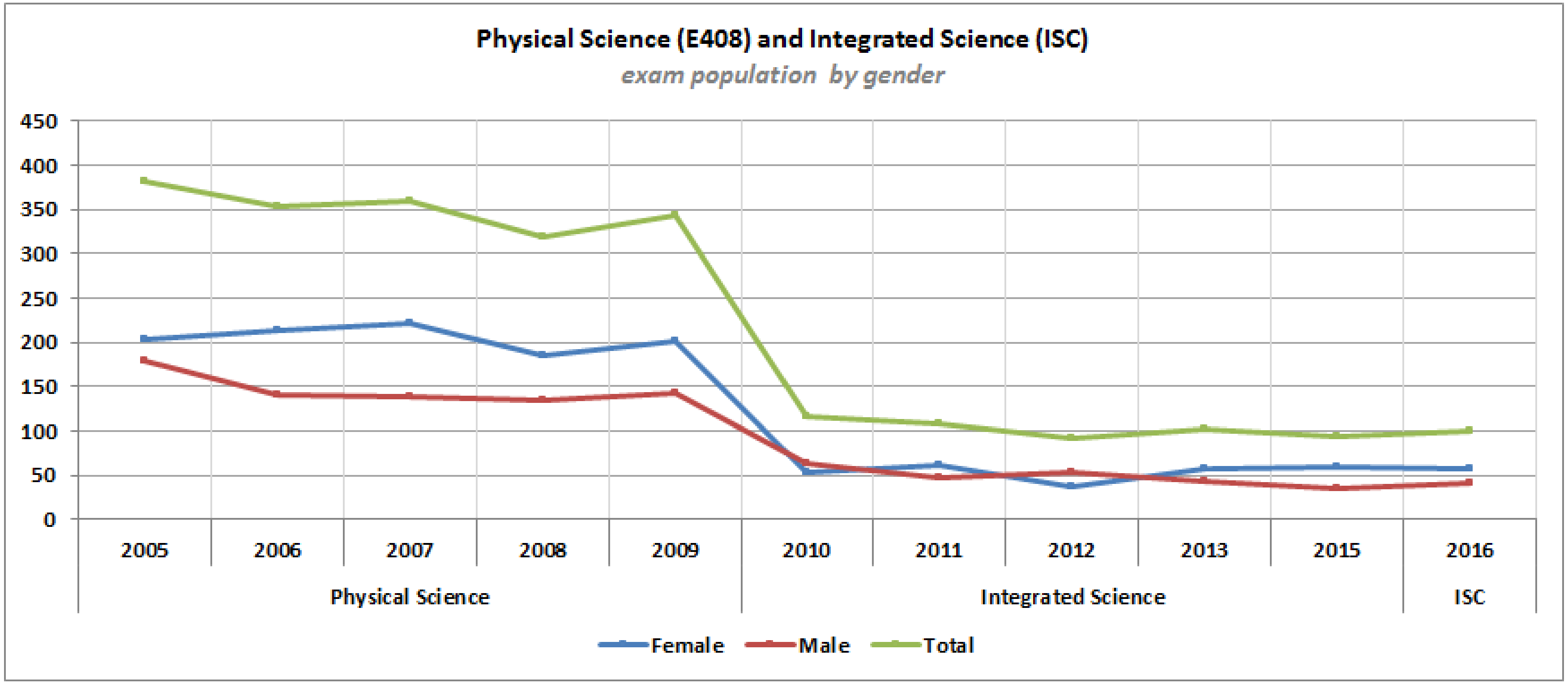


Table 6a – Number of examination candidates by gender in TEE E408 subject, ISC Stage 3 course and ISC ATAR course

Exam	Physical Science (E408)					Integrated Science (ISC)					ISC
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	203	213	221	184	201	54	61	37	57	59	58
Male	178	141	139	135	142	63	47	54	44	35	41
Total	**381**	**354**	**360**	**319**	**343**	**117**	**108**	**91**	**101**	**94**	**99**

Graph 6b – Integrated Science (ISC) and TEE (E408) Physical Science

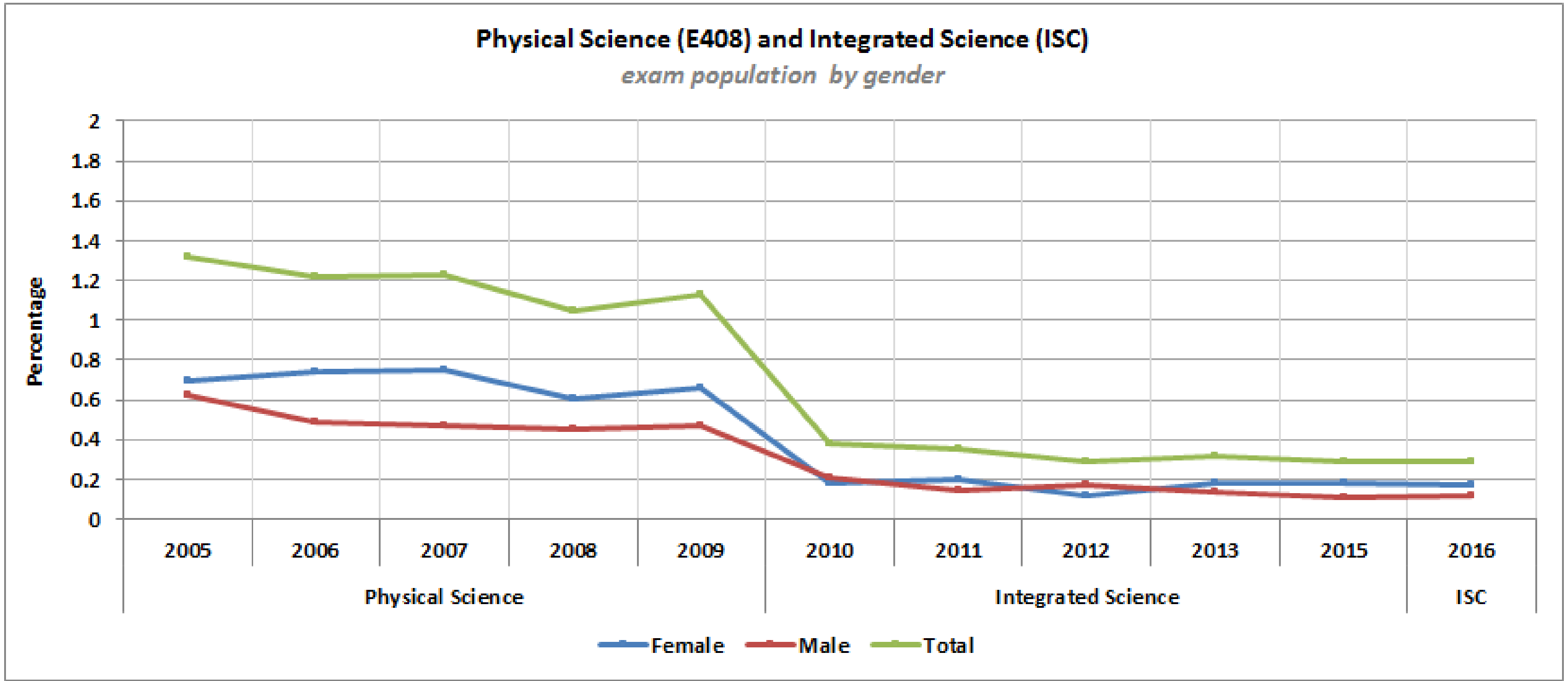


Table 6b – Examination candidates by gender in TEE E408 subject, ISC Stage 3 course and ISC ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	**Physical Science (E408)**					**Integrated Science (ISC)**					**ISC**
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	0.70	0.74	0.75	0.61	0.66	0.18	0.20	0.12	0.18	0.18	0.17
Male	0.62	0.49	0.47	0.45	0.47	0.21	0.15	0.17	0.14	0.11	0.12
Total	**1.32**	**1.22**	**1.23**	**1.05**	**1.13**	**0.38**	**0.35**	**0.29**	**0.32**	**0.29**	**0.29**

Graph 7a – Chemistry (CHE) and TEE (E403) Chemistry

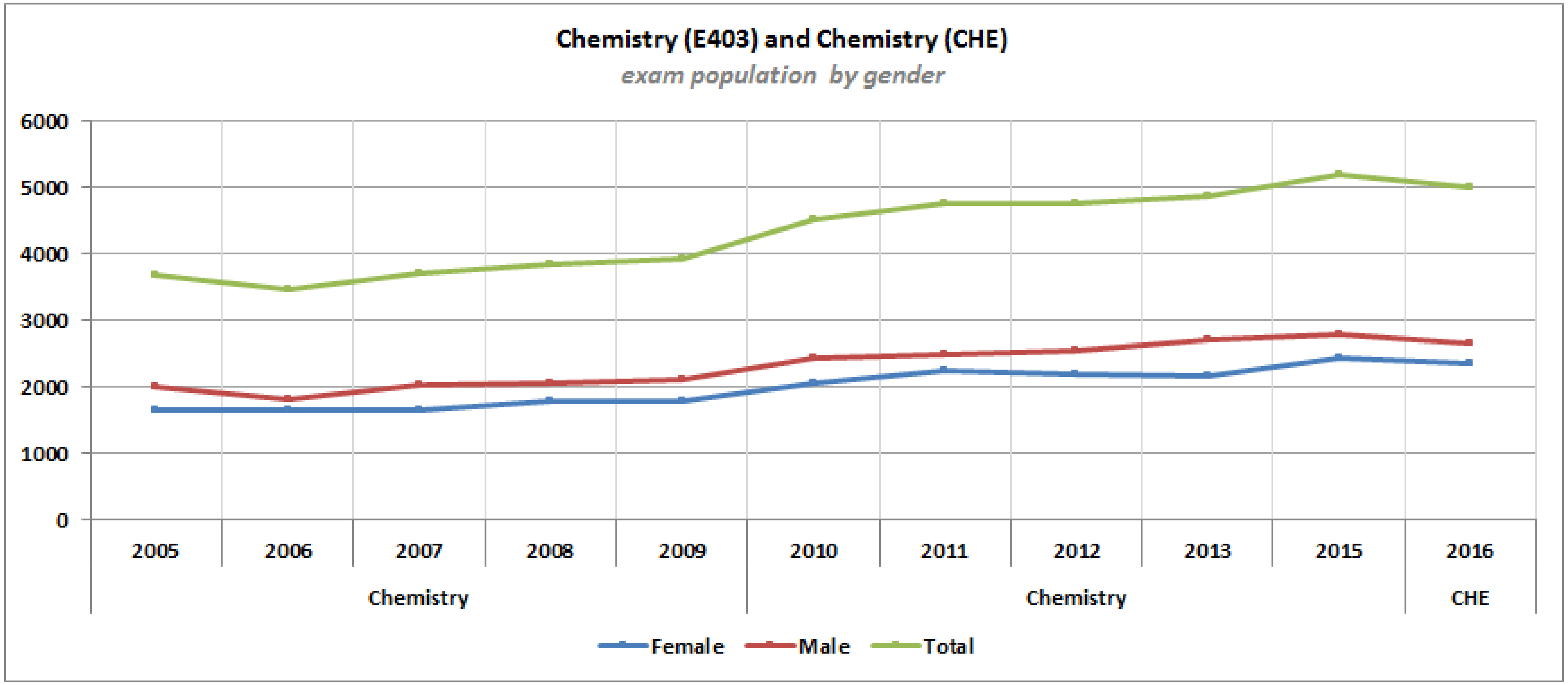


Table 7a – Number of examination candidates by gender in TEE E403 subject, CHE Stage 3 course and CHE ATAR course

Exam	**Chemistry (E403)**					**Chemistry (CHE)**					**CHE**
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	1664	1661	1660	1779	1795	2066	2261	2202	2178	2432	2362
Male	2019	1816	2040	2072	2119	2443	2492	2553	2709	2778	2645
Total	**3683**	**3477**	**3700**	**3851**	**3914**	**4509**	**4753**	**4755**	**4887**	**5210**	**5007**

Graph 7b – Chemistry (CHE) and TEE (E403) Chemistry

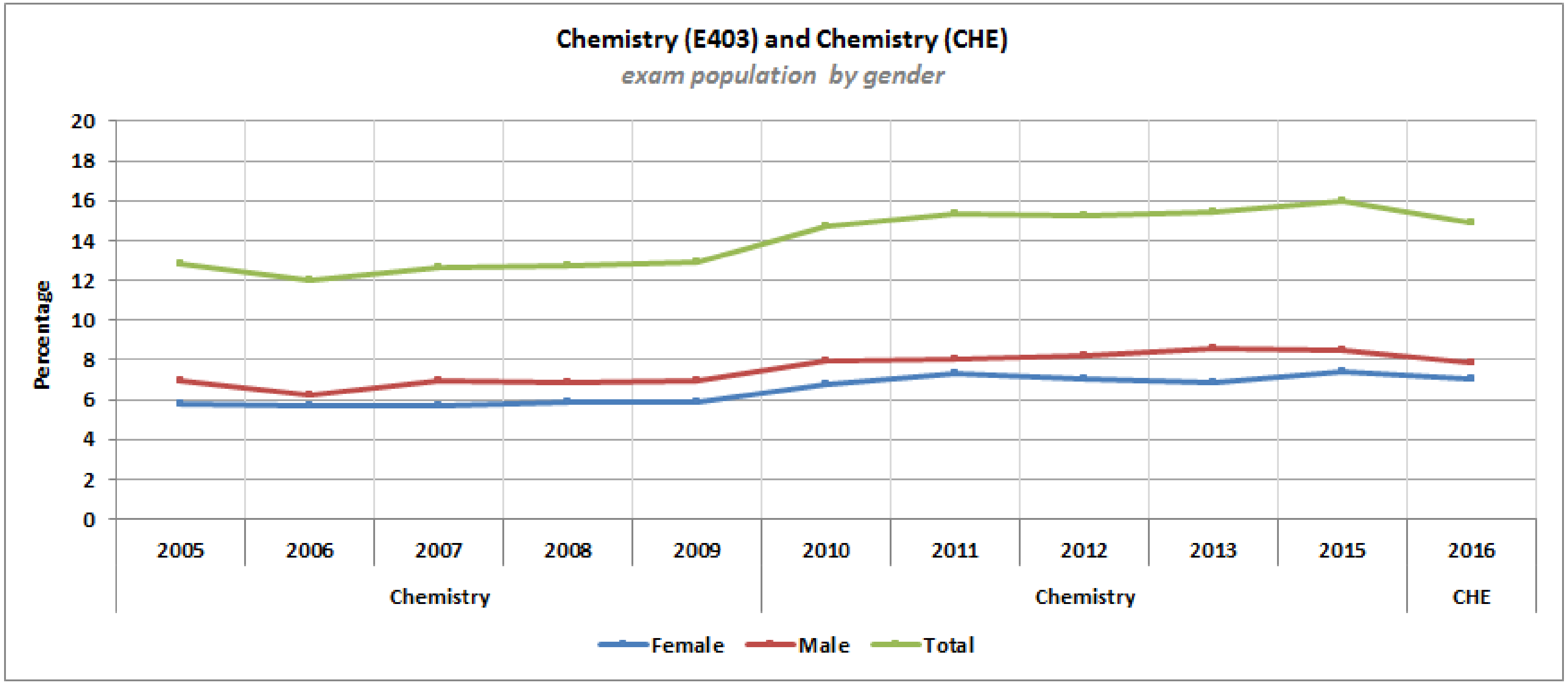


Table 7b – Examination candidates by gender in TEE E403 subject, CHE Stage 3 course, CHE ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Chemistry (E403)				Chemistry (CHE)					
ABS popln.	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	5.74	5.67	5.88	5.91	6.74	7.29	7.08	6.88	7.45	7.02
Male	6.27	6.97	6.85	6.98	7.97	8.04	8.21	8.56	8.51	7.86
Total	**12.01**	**12.64**	**12.74**	**12.89**	**14.72**	**15.33**	**15.29**	**15.44**	**15.96**	**14.88**

Graph 8a – Physics (PHY) and TEE (E409) Physics

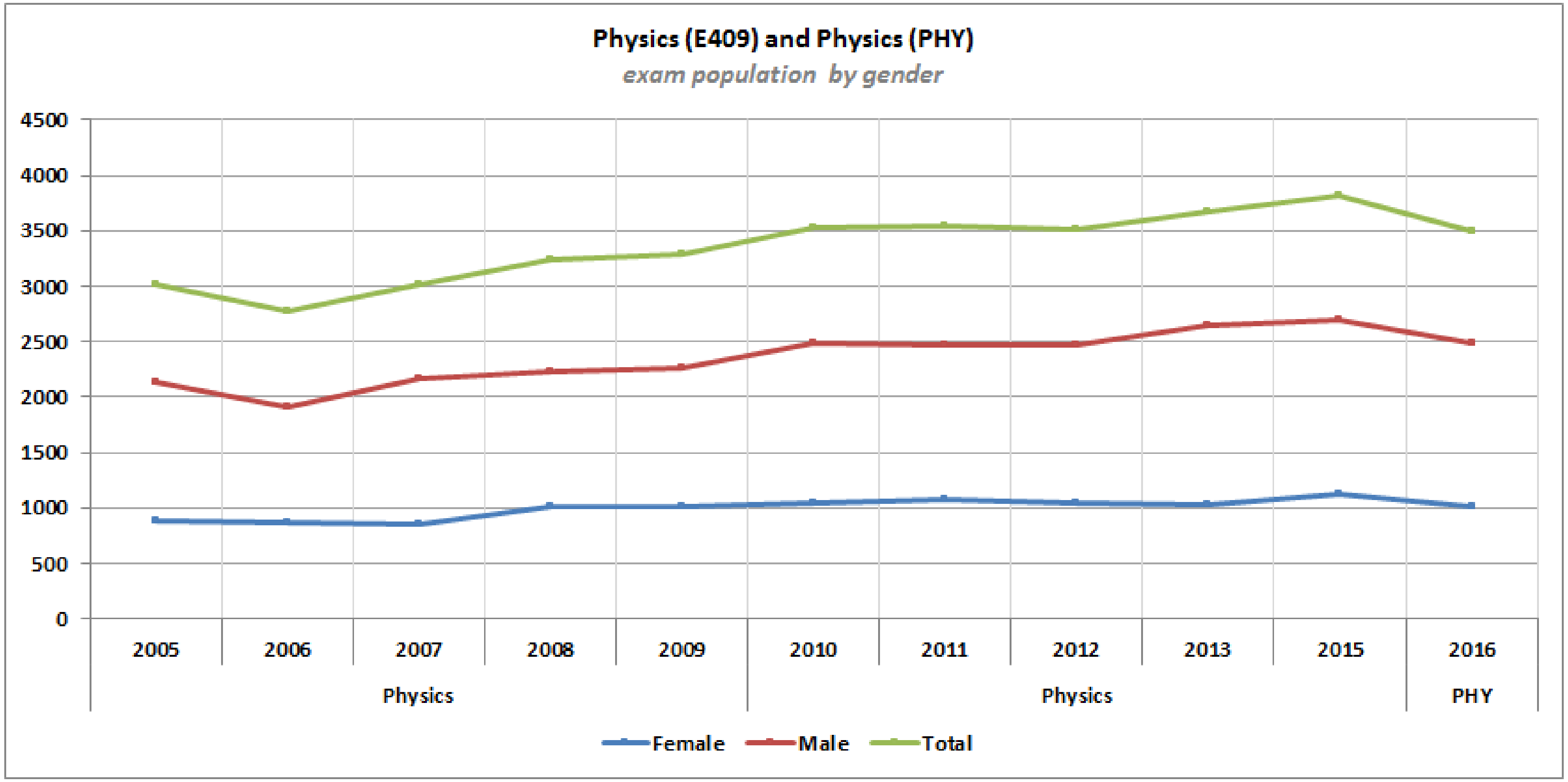


Table 8a – Number of examination candidates by gender in TEE E409 subject, PHY Stage 3 course and PHY ATAR course

Exam	**Physics (E409)**					**Physics (PHY)**					
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	879	865	861	1008	1019	1047	1077	1044	1023	1132	1006
Male	2142	1913	2159	2235	2269	2488	2474	2464	2654	3688	2492
Total	**3021**	**2778**	**3020**	**3243**	**3288**	**3535**	**3551**	**3508**	**3667**	**3820**	**3498**

Graph 8b – Comparison of Physics (PHY) and TEE (E409) Physics

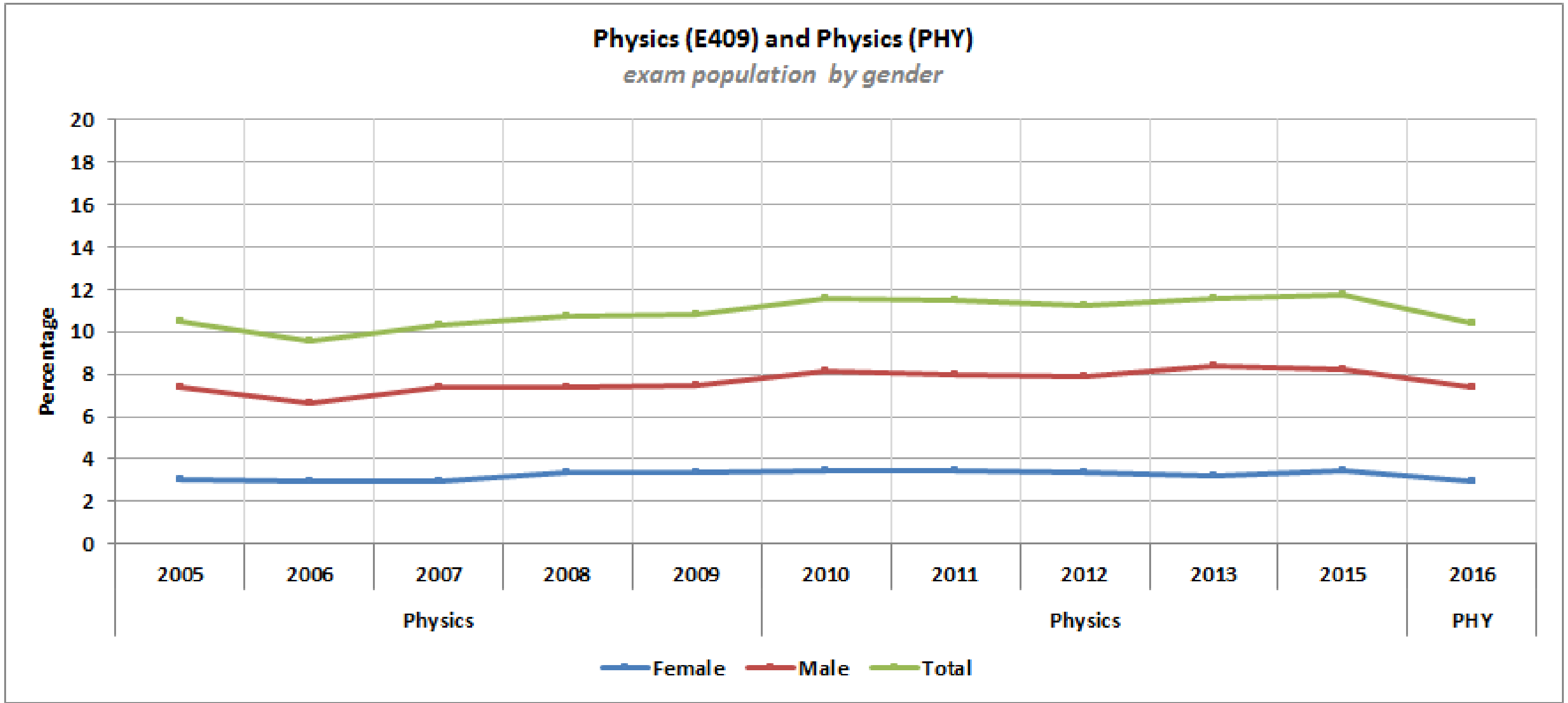


Table 8b – Examination candidates by gender in TEE E409 subject, PHY Stage 3 course, PHY ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam			**Physics (E409)**					**Physics (PHY)**			**PHY**
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	3.05	2.99	2.94	3.33	3.36	3.42	3.47	3.36	3.23	3.47	2.99
Male	7.43	6.61	7.38	7.39	7.47	8.12	7.98	7.92	8.38	8.24	7.41
Total	**10.48**	**9.59**	**10.32**	**10.73**	**10.83**	**11.54**	**11.46**	**11.28**	**11.61**	**11.71**	**10.39**

Graph 9a – Mathematics Methods (MAM), Mathematics Stage 3CD (MAT3CD) and TEE (E504) Applicable Mathematics

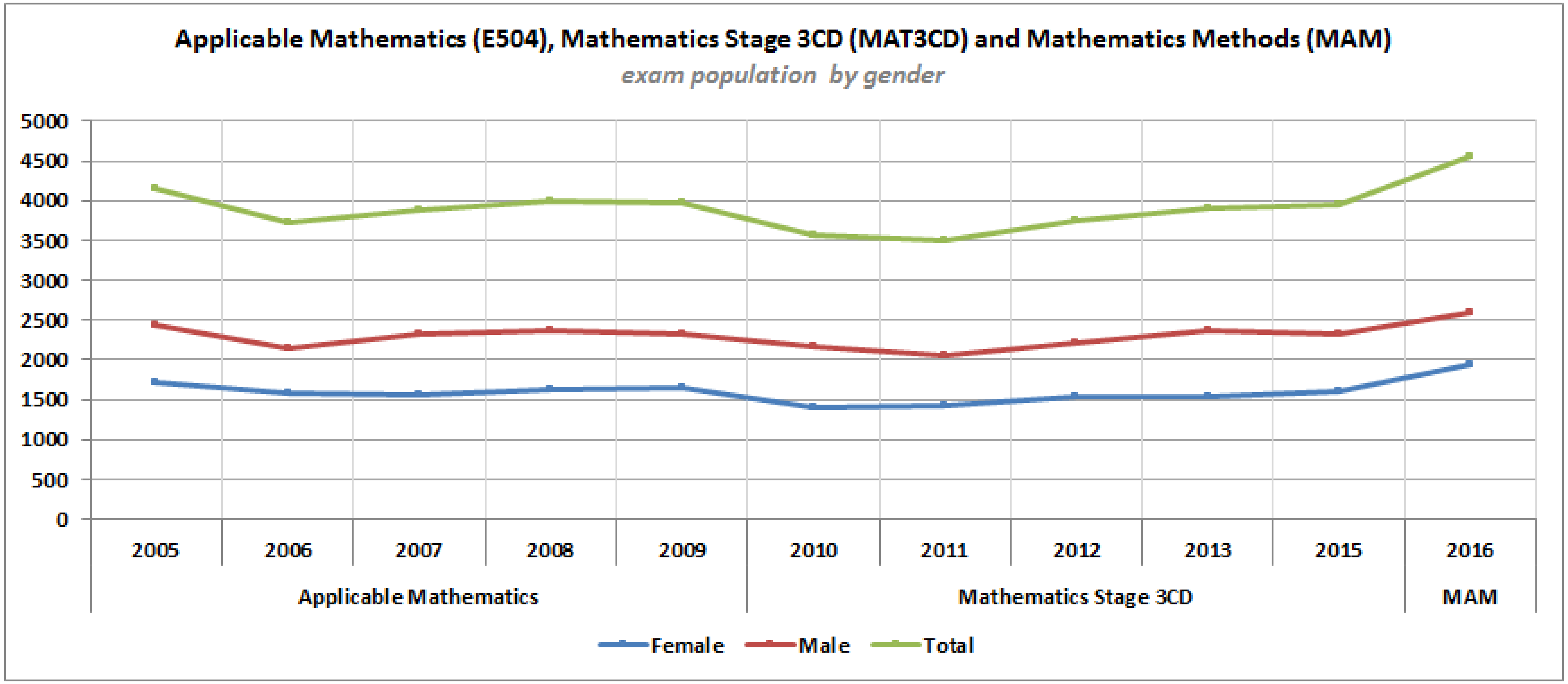


Table 9a – Number of examination candidates by gender in TEE E504 subject, MAT Stage 3CD course, MAM ATAR course

Exam	Applicable Mathematics (E504)					Mathematics Stage 3CD (MAT3CD)					Mathematics Methods (MAM)
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	1711	1587	1557	1628	1645	1406	1422	1544	1532	1612	1949
Male	2443	2145	2323	2369	2330	2164	2066	2213	2369	2335	2599
Total	**4154**	**3732**	**3880**	**3997**	**3975**	**3570**	**3488**	**3757**	**3901**	**3947**	**4548**

Graph 9b – Comparison of Mathematics Stage 3CD (MAT3CD) and TEE (E504) Applicable Mathematics

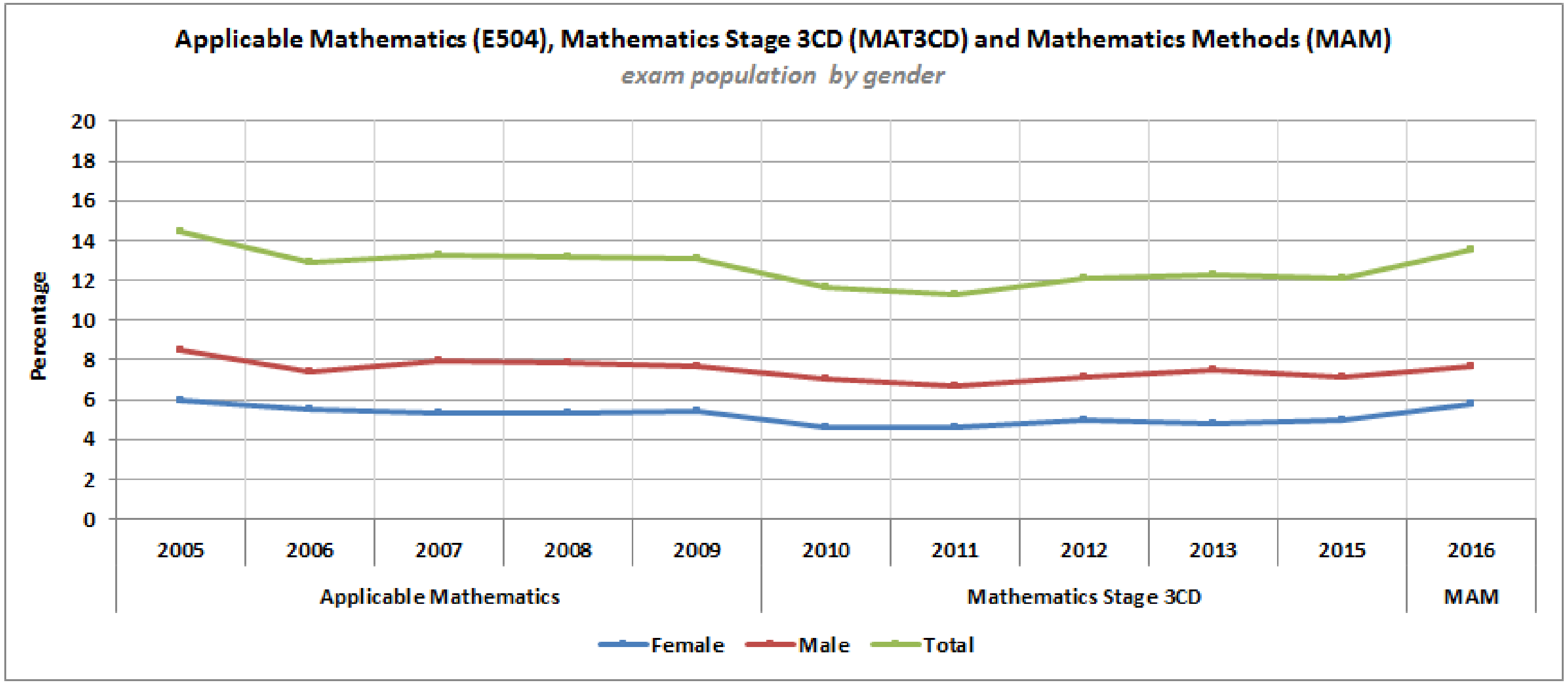


Table 9b – Examination candidates by gender in TEE E504 Subject, MAT Stage 3CD course, MAM ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Applicable Mathematics (E504)					Mathematics Stage 3CD (MAT3CD)					Mathematics Methods (MAM)
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	5.94	5.48	5.32	5.38	5.42	4.59	4.59	4.96	4.84	4.94	5.79
Male	8.48	7.41	7.94	7.83	7.67	7.06	6.67	7.11	7.48	7.16	7.72
Total	**14.41**	**12.89**	**13.25**	**13.22**	**13.09**	**11.65**	**11.25**	**12.08**	**12.32**	**12.09**	**13.51**

Graph 10a – Mathematics Specialist (MAS), Mathematics: Specialist Stage 3CD (MAS3CD) and TEE (E506) Calculus

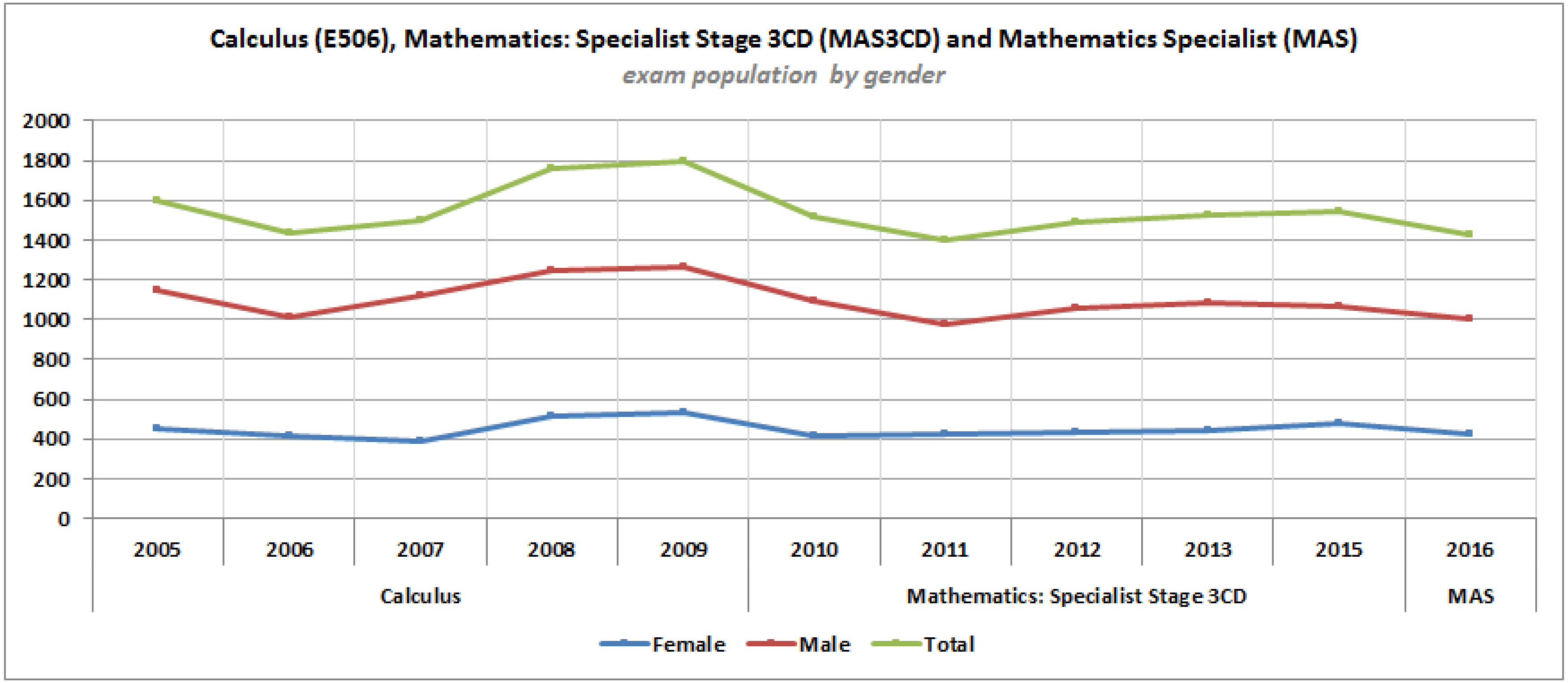


Table 10a – Number of examination candidates by gender in TEE E506 subject, MAS Stage 3CD course and MAS ATAR course

Exam	Calculus (E506)					Mathematics: Specialist Stage 3CD (MAS3CD)					Mathematics Specialist (MAS)
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	451	421	386	516	532	419	424	432	443	483	422
Male	1150	1013	1116	1248	1262	1094	972	1061	1084	1064	1007
Total	**1601**	**1434**	**1502**	**1764**	**1794**	**1513**	**1396**	**1493**	**1527**	**1547**	**1429**

Graph 10b – Mathematics Specialist (MAS), Mathematics: Specialist Stage 3CD (MAS3CD) and TEE (E506) Calculus

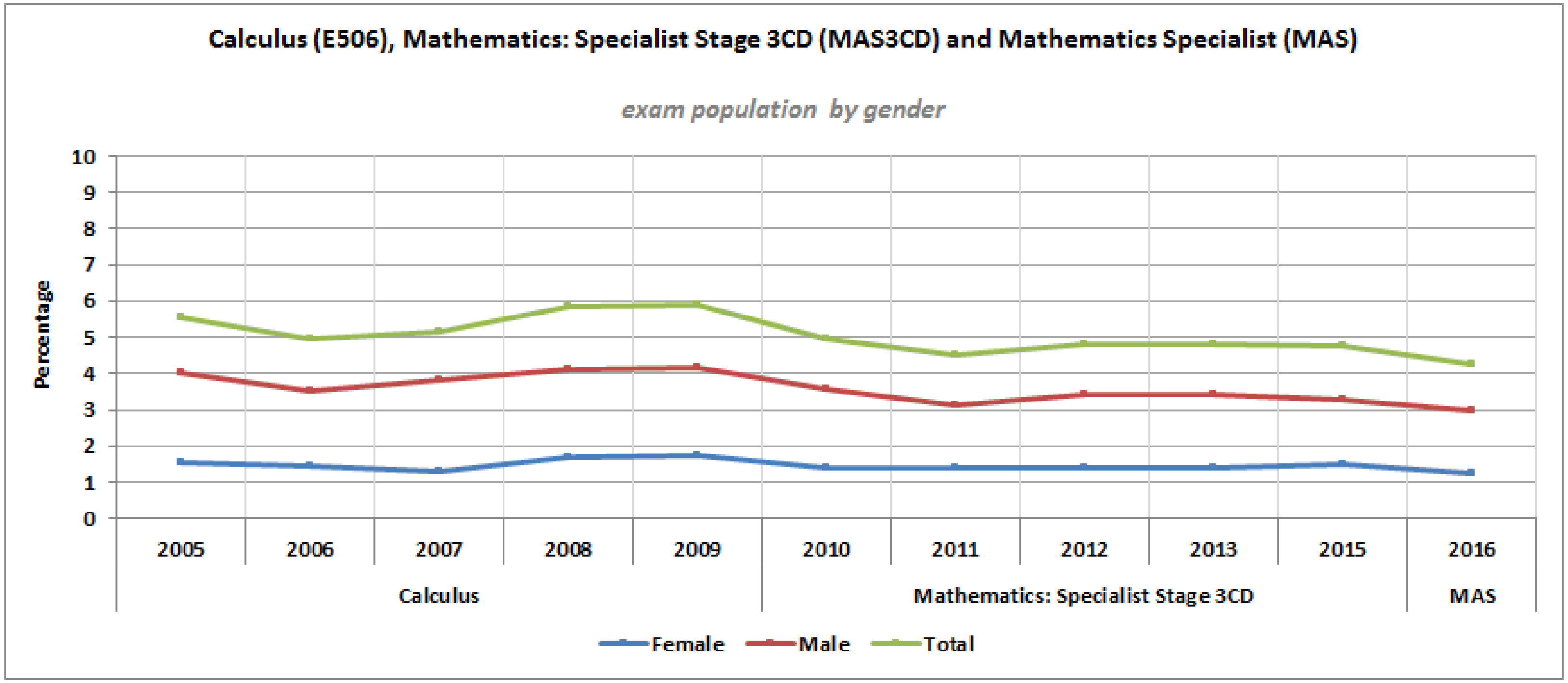


Table 10b – Examination candidates by gender in TEE E506 subject, MAS3CD examination and MAS ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Calculus (E506)					Mathematics: Specialist Stage 3CD (MAS3CD)					MAS
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	1.56	1.45	1.32	1.71	1.75	1.37	1.37	1.39	1.40	1.48	1.25
Male	3.99	3.50	3.81	4.13	4.16	3.57	3.14	3.41	3.42	3.26	2.99
Total	**5.55**	**4.95**	**5.13**	**5.83**	**5.91**	**4.94**	**4.50**	**4.80**	**4.82**	**4.74**	**4.25**

Graph 11a – Mathematics Applications (MAA), Mathematics Stage 2CD and Stage 3AB (MAT2CD & MAT3AB) WACE exams and TEE (E502) Discrete Mathematics

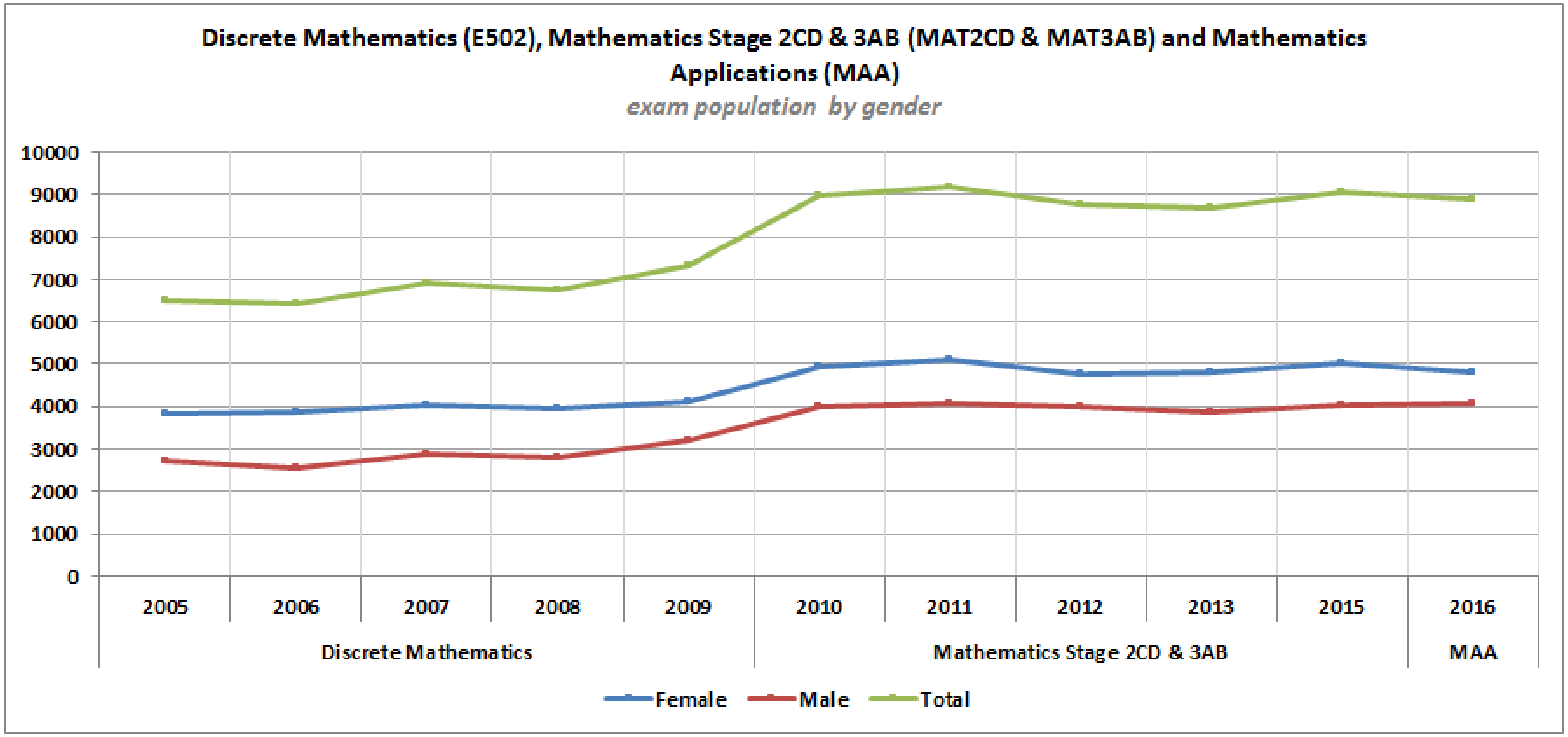


Table 11a – Number of examination candidates by gender in TEE E502 subject, MAT2CD & MAT3AB examinations and MAA ATAR course

Exam	Discrete Mathematics (E502)					Mathematics Stage 2CD & 3AB (MAT2CD & MAT3AB)					MAT2CD					MAT3AB					MAA
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2010*	*2011*	*2012*	*2013*	*2015*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	3815	3875	4029	3967	4115	4939	5103	4760	4813	5015	2900	2680	2315	2279	2123	2039	2423	2445	2534	2892	4820
Male	2704	2561	2876	2783	3200	4011	4089	3985	3884	4019	2194	1884	1787	1708	1515	1817	2205	2198	2176	2504	4076
Total	**6519**	**6436**	**6905**	**6750**	**7315**	**8950**	**9192**	**8745**	**8697**	**9034**	**5094**	**4564**	**4102**	**3987**	**3638**	**3856**	**4628**	**4643**	**4710**	**5396**	**8896**

Graph 11b – Mathematics Applications (MAA), Mathematics Stage 2CD and Stage 3AB (MAT2CD & MAT3AB) WACE examinations and TEE (E502) Discrete Mathematics

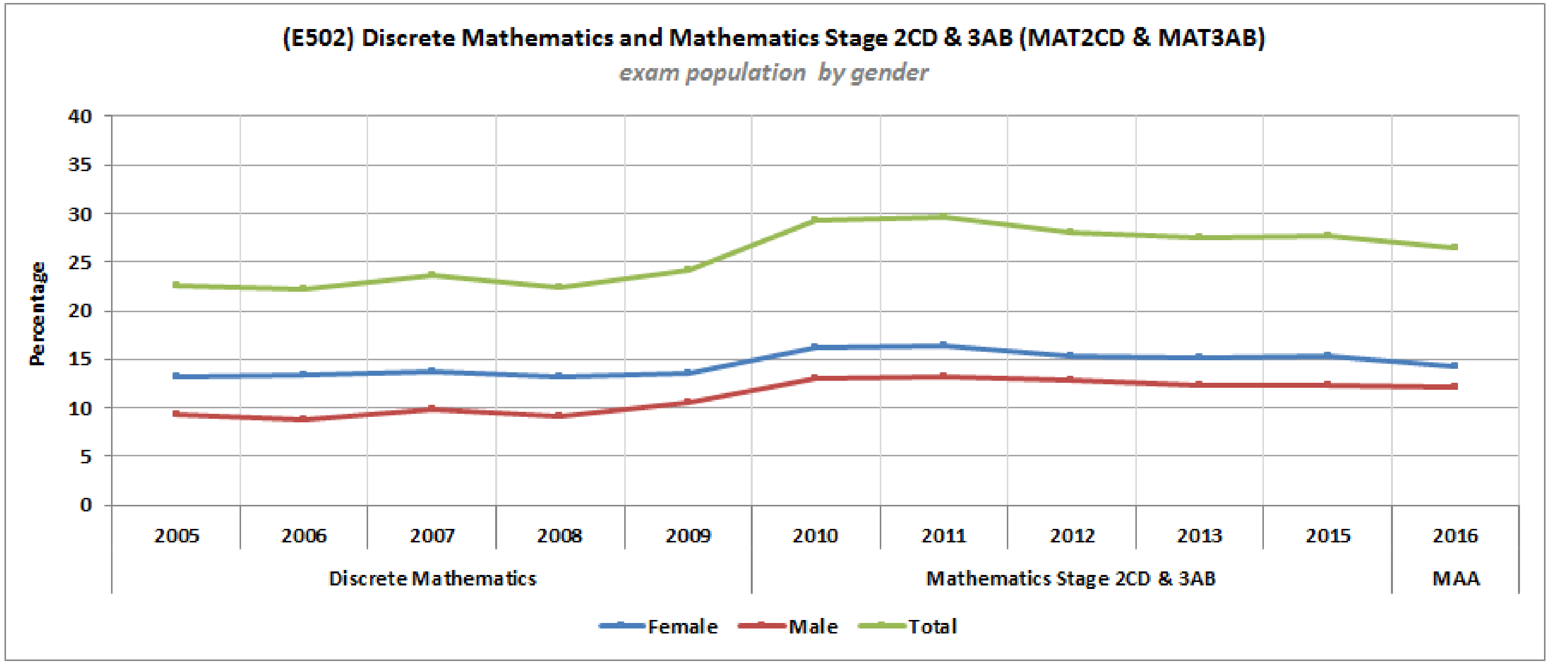


Table 11b – Examination candidates by gender in TEE E502 subject, MAT2CD & MAT3AB examinations and MAA ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Discrete Mathematics (E502)					Mathematics Stage 2CD & 3AB (MAT2CD & MAT3AB)					MAT2CD					MAT3AB					MAA
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*30635*	*30997*	*31107*	*31658*	*32634*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2010*	*2011*	*2012*	*2013*	*2015*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	13.24	13.38	13.76	13.12	13.55	16.12	16.46	15.30	15.20	15.37	9.47	8.65	7.44	7.20	6.51	3.42	3.47	3.36	3.23	8.86	14.32
Male	9.38	8.85	9.82	9.20	10.54	13.09	13.19	12.81	12.27	12.32	7.16	6.08	5.74	5.40	4.64	8.12	7.98	7.92	8.38	7.67	12.11
Total	**22.62**	**22.23**	**23.59**	**22.32**	**24.09**	**29.21**	**29.65**	**28.11**	**27.47**	**27.68**	**16.63**	**14.72**	**13.19**	**12.59**	**11.15**	**11.54**	**11.46**	**11.28**	**11.61**	**16.53**	**26.44**

Graph 11a.1 – Mathematics Applications (MAA), Mathematics Stage 3AB (MAT3AB) WACE examination and TEE (E502) Discrete Mathematics

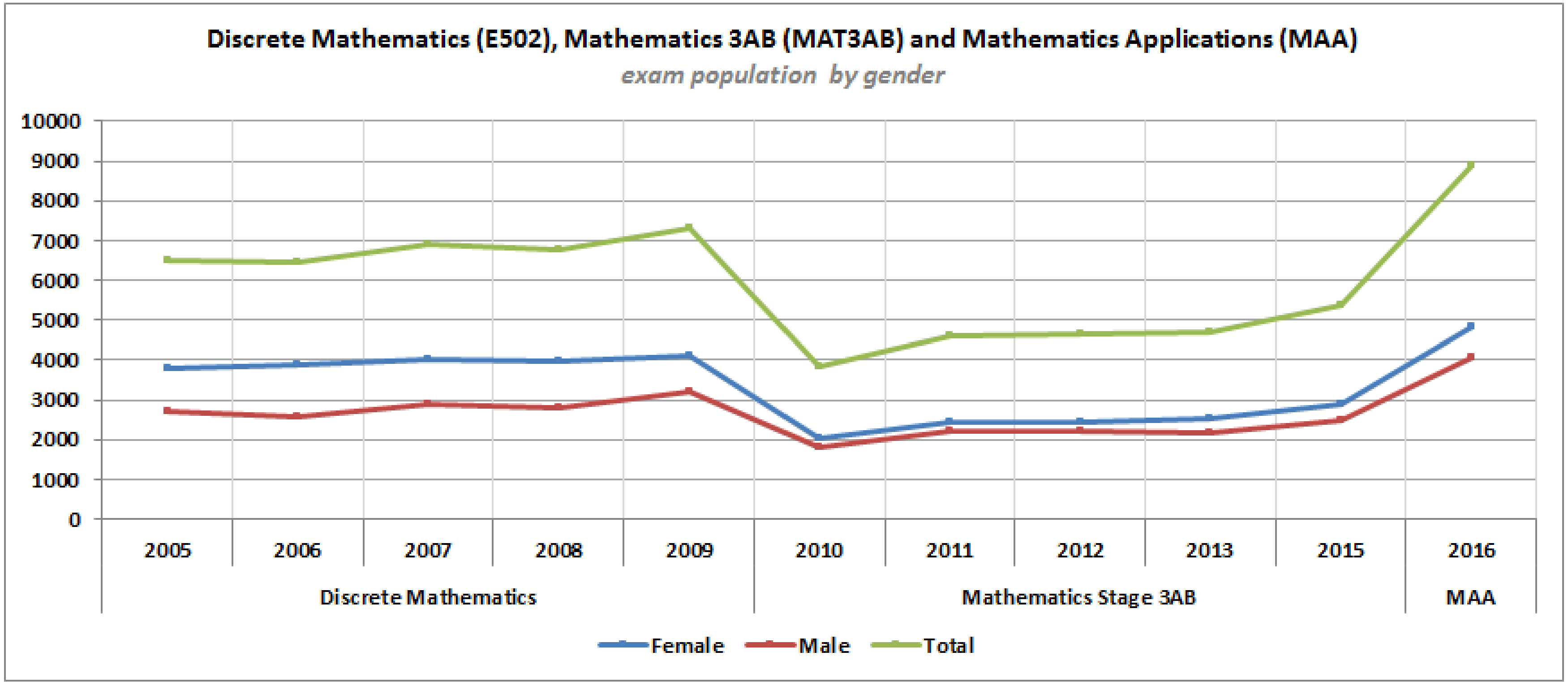


Table 11a.1 – Number of examination candidates by gender in TEE E502 subject, MAT3AB examination and MAA ATAR course

Exam	Discrete Mathematics (E502)					Mathematics Stage 3AB (MAT3AB)					MAA
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	3815	3875	4029	3967	4115	2039	2423	2445	2534	2892	4820
Male	2704	2561	2876	2783	3200	1817	2205	2198	2176	2504	4076
Total	**6519**	**6436**	**6905**	**6750**	**7315**	**3856**	**4628**	**4643**	**4710**	**5396**	**8896**

Graph 11b.1 – Mathematics Applications (MAA), Mathematics Stage 3AB (MAT3AB) WACE examination and TEE (E502) Discrete Mathematics

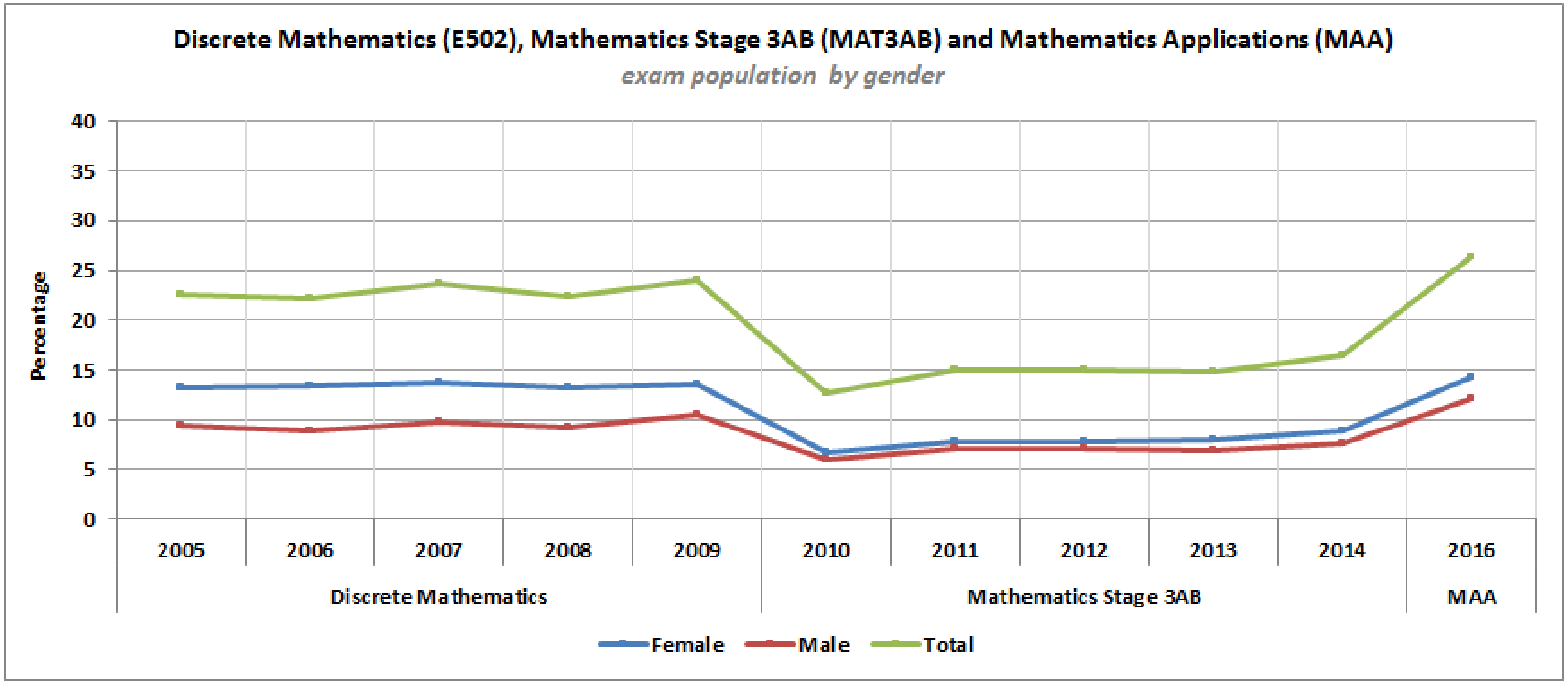


Table 11b.1 – Examination candidates by gender in TEE E502 subject, MAT3AB examination and MAA ATAR course

Percentages are calculated relative to weighted ABS population for that year.

Exam	Discrete Mathematics (E502)					Mathematics Stage 3AB (MAT3AB)					MAA
ABS popln.	*28823*	*28954*	*29273*	*30237*	*30367*	*30635*	*30997*	*31107*	*31658*	*32634*	*33652*
Year	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2015*	*2016*
Female	13.24	13.38	13.76	13.12	13.55	3.42	3.47	3.36	3.23	8.86	14.32
Male	9.38	8.85	9.82	9.20	10.54	8.12	7.98	7.92	8.38	7.67	12.11
Total	**22.62**	**22.23**	**23.59**	**22.32**	**24.09**	**11.54**	**11.46**	**11.28**	**11.61**	**16.53**	**26.44**